OLYM

Elwha River

Ecosystem Restoration Implementation

Draft Environmental
Impact Statement
April 1996

Olympic National Park
Washington

Cover Photos: Underwater view of chinook salmon in the Elwha River/Elwha River scene, 1995.
(photos by Natalie Fobes, author of Pacific Salmon, Pacific People*)*

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Draft Environmental Impact Statement

Elwha River Ecosystem Restoration Implementation

Purpose and Need: The Elwha River ecosystem and native anadromous fisheries are severely degraded as a result of two hydroelectric dams (projects) and their reservoirs built in the early 1900s. Congress has mandated the full restoration of this ecosystem and its native anadromous fisheries through the Elwha River Ecosystem and Fisheries Restoration Act (Public Law 102-495). The Department of the Interior has found there is a need to return this river and the ecosystem to its natural, self-regulating state, and proposes to implement the Congressional mandate by removing both dams in a safe, environmentally sound and cost effective manner and implementing fisheries and ecosystem restoration planning. No other alternative would fully restore the ecosystem or its native anadromous fisheries.

Proposed Action – River Erosion Alternative: The U.S. Department of the Interior proposes to fully restore the Elwha River ecosystem and native anadromous fisheries through the removal of Elwha Dam and Glines Canyon Dam and implementing fish restoration and revegetation. Dam removal would occur over an 18-month to 2-year period. Elwha Dam would be removed by blasting, and Glines Canyon Dam by a combination of blasting and diamond-wire saw cutting. Lake Aldwell would be drained by a diversion channel, and Lake Mills by notching down Glines Canyon Dam. Stored sediment would be eroded naturally by the Elwha River. The project area is located in Clallam County, on the Olympic Peninsula, in Washington State.

Lead agency: National Park Service

Cooperating agencies: U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, U.S. Bureau of Indian Affairs, U.S. Army Corps of Engineers, and the Lower Elwha Klallam Tribe

Type of statement: This is a draft environmental impact statement which is procedurally connected (tiered) to the Department of the Interior Elwha River Ecosystem Restoration Final Environmental Impact Statement (June 1995). This statement examines alternatives for implementing the policy choice to remove both Elwha and Glines Canyon Dam based on Interior's Elwha River Ecosystem Restoration statement.

Abstract: In addition to the proposed action, two other alternatives are examined. They are: the Dredge and Slurry alternative (removing fine-grained sediment prior to dam removal by using suction dredges, and sending the slurry to the Strait of Juan de Fuca in a pipeline), and No Action (dams are retained as is, without fish passage measures). The proposed action is also the Department of the Interior's preferred alternative. Short-term negative impacts from removing both dams could result from the release of sediment now trapped in the reservoirs. The finer grained particles could temporarily but significantly impact fish or other aquatic organisms. Impacts on water quality, river morphology, flooding, native anadromous and resident (e.g. trout and char) fisheries, living marine resources, wildlife, threatened and endangered species, vegetation, cultural resources, land use, recreation, aesthetics, and socioeconomics are examined in this environmental impact statement. Both of the other alternatives would also have significant impacts on resources examined in this document.

Public Comment Period: Written comments will be taken for a period of 60 days on the draft environmental impact statement. They should be sent to Sarah Bransom, National Park Service, Denver Service Center, Resource Planning, DSC-RP, 12795 West Alameda Parkway, P.O. Box 25287, Denver, Colorado 80225-0287, phone (303)969-2210. Public meetings to take oral and/or written comments will be scheduled during this time. Questions on the project should be addressed to Dr. Brian Winter, Elwha Project Leader, at Olympic National Park in Port Angeles, (360) 452-0302.

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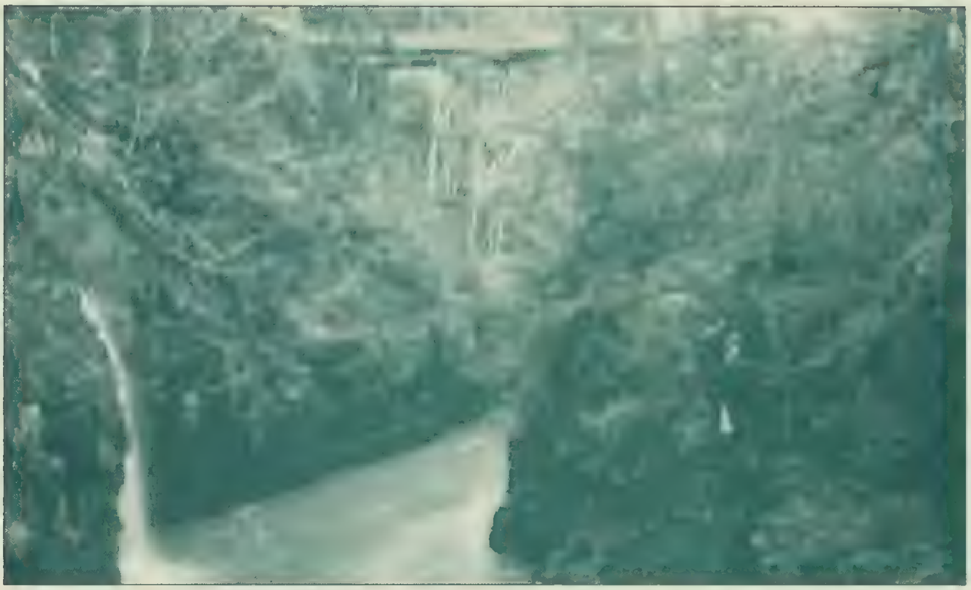
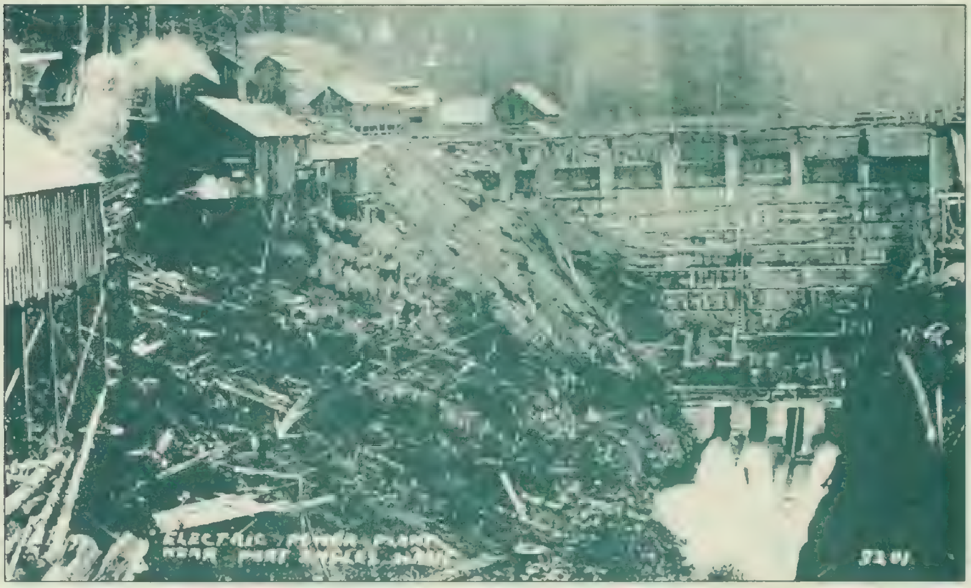
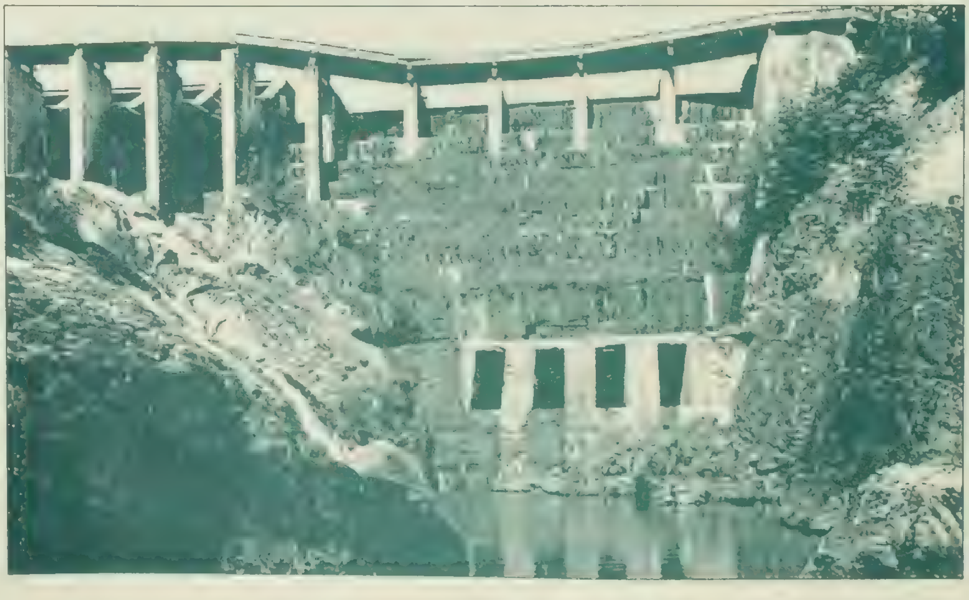






Previous page: Site of present Elwha Dam prior to construction of bridge, circa 1895–1900. (Daishowa/James River Company photo)

1. Bridge at site of Elwha Dam, circa 1910. (Clallam County Historical Society photo)

2. The first Elwha Dam near completion, circa 1911. (Daishowa/James River Company photo)

3. Elwha Dam, no date. (Daishowa/James River Company photo)

Summary

Introduction

This document is a draft environmental impact statement (DEIS), prepared to analyze environmental impacts of alternative ways to remove two hydroelectric projects on the Elwha River. This DEIS is the second of two, which in combination study how to fully restore the river's dam-altered ecosystem and native anadromous fisheries in a safe, environmentally sound and cost-effective manner. The first, "programmatic" EIS (Elwha River Ecosystem Restoration Final Environmental Impact Statement) was finalized in June, 1995. The programmatic EIS is procedurally connected (tiered) to this document, the *Implementation EIS*.

Professionals in a variety of technical fields from a group of federal agencies and the Lower Elwha Klallam Tribe, as well as consultants and the public helped define project objectives and the range of reasonable alternatives. They also analyzed the impacts of those alternatives to important environmental resources. The National Park Service is the lead agency in the production of this analysis and documentation, and the US Bureau of Reclamation, US Fish and Wildlife Service, US Bureau of Indian Affairs, US Army Corps of Engineers and Lower Elwha Klallam Tribe are cooperating agencies. This team of agency preparers and contributors is referred to throughout this document as the EIS Team.

The action proposed... in this environmental impact statement is the full restoration of the Elwha River ecosystem and native anadromous fisheries...

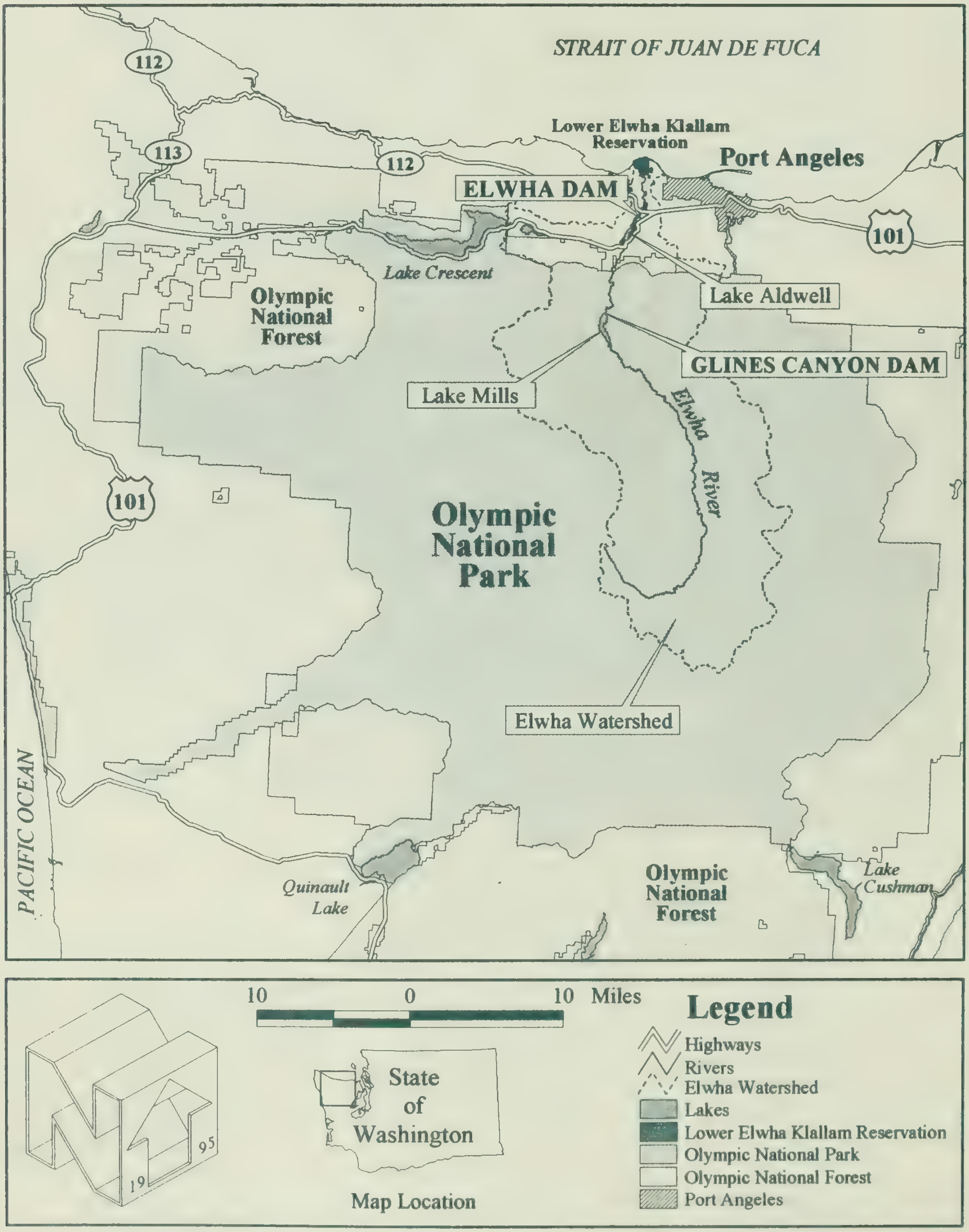
Purpose and Need

The action proposed and analyzed in this environmental impact statement is the full restoration of the Elwha River ecosystem and native anadromous fisheries through the removal of two hydroelectric dams and implementation of fisheries restoration and revegetation. The dams were installed without fish passage facilities on the Elwha River, on the Olympic Peninsula in Washington State (figure 1). Elwha Dam was built first, 4.9 miles from the mouth of the river. Construction spanned the years 1910–1914. Glines Canyon Dam was completed 8.5 miles further upstream in 1927. Both impound reservoirs: the Elwha Dam forms the Lake Aldwell reservoir, and Glines Canyon Dam forms the Lake Mills reservoir.

Before the dams were built, the Elwha River produced an estimated 380,000 migrating salmon and trout. The construction of Elwha Dam eliminated 93% of Elwha River habitat for these anadromous fish, and began what became a precipitous decline in the native populations of all 10 runs of Elwha salmon and sea-going trout.

Salmon populations in the Elwha River are not the only ones declining, nor are dams the only reason for their decline. Salmonid numbers in many rivers

Figure 1. *Location Map*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20055B



of the Pacific Northwest are falling for a variety of reasons. Some species are overfished, some are affected on a large scale by fluctuations in the marine environment, and some are affected by conditions in their freshwater habitat. Silt from logging, dredging for gold and from the building and use of roads covers and smothers eggs. Water diversions for industrial, municipal or commercial use, and the addition of pollutants such as pesticides all increase fish disease and mortality.

However, dams, even with fish measures installed, are a primary cause of fish mortality. It is estimated the series of dams on the Columbia-Snake river system kill 85 to 95% of migrating smolts on their way to sea, and between 34 and 57% of adults returning to spawn (Sims 1994). This is despite an estimated $1.5 billion spent over the last 13 years to implement fish passage measures on the Columbia and Snake rivers (Satchell 1994). Degraded freshwater habitat is often expensive and difficult to restore because of developments like dams, roads, agriculture, and water withdrawals for municipal and industrial use. In contrast, the Elwha River remains in pristine condition along most of its length. The single action of removing both dams would restore to pre-dam, high quality condition the vast majority of habitat formerly available to Elwha anadromous fish.

Several specific problems for native anadromous fish and the Elwha River ecosystem are a direct result of the dams. Neither dam has passage measures for fish, and so they obstruct upstream fish migration beyond the first 4.9 miles of the river. The natural transport of coarse sediment downstream has also been halted by the dams and its resulting absence has rendered the river downstream of the dams largely unusable by fish. Salmon and steelhead once filled 70 miles of mainstem and tributary habitat in the Elwha. Their carcasses fed more than 22 species of wildlife and supplied the entire aquatic ecosystem with organic material, phosphorus and nitrogen. Now, populations of primarily hatchery fish return to only the 4.9 miles of river below the Elwha Dam to spawn in crowded, unnatural and poor quality conditions. Both the terrestrial and aquatic ecosystems are less productive and varied as a result.

Humans have occupied the Elwha valley for thousands of years, and have integrated the river and its salmon into much of their daily lives. When the dams separated the fish from their spawning grounds and populations rapidly declined, the Elwha Klallam people were affected culturally, spiritually and economically. Many tribal socioeconomic problems which persist today have had their roots in this decline. The dams are also inconsistent with the federal trust responsibility and treaty rights guaranteed to the Elwha Klallam and three other Indian tribes in the 1855 Treaty of Point No Point and the Treaty with the Makah.

Chinook salmon in the lower Elwha River. (Natalie Fobes photo)

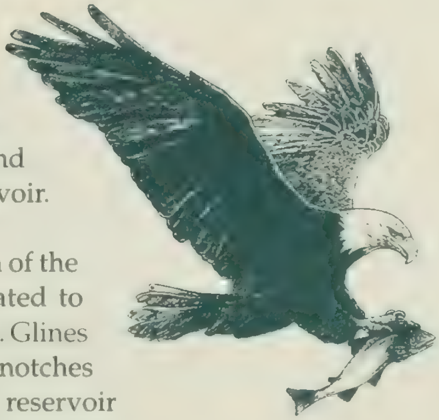
Because the dams and reservoirs on the Elwha River have caused and continue to cause major, adverse impacts to the river's native anadromous fish populations, wildlife, aquatic ecology and cultural resources, the Department of the Interior determined in its programmatic environmental impact statement they would be removed to fully restore the ecosystem and native anadromous fisheries. This EIS examines alternative methods of removing them in a safe, environmentally sound and cost-effective manner and proposes a plan to restore the river's native anadromous fisheries and ecosystem.

Alternatives

The proposed action (the River Erosion alternative) is to initiate river restoration by removing both dams over a two-year period. Lake Mills would initially be drawn down with Glines Canyon Dam in place to provide flood control water storage until a diversion channel to drain Lake Aldwell is complete. Elwha Dam would be removed by controlled blasting, and Glines Canyon Dam would be removed by a combination of controlled blasting and diamond wire saw cutting of concrete blocks. Sediment would be eroded naturally by the river.

The proposed action would involve lowering Lake Aldwell enough to build a temporary cofferdam and excavate a diversion channel through the north spillway. The reservoir would be lowered through the channel enough to remove fill material, which now serves to control seepage through the dam

Fishing the Elwha in the 1920s. (Asahel Curtis photo, Washington State Historical Society)



foundation. Elwha Dam would then be blasted in sections, and rubble trucked to one or more of nine disposal sites under consideration within a 32-mile radius. Some project features outside the river channel may be buried under backfill material. During the low flow period of the second year, the river channel and dam would be lowered in increments to completely drain the reservoir.

Removal of Glines Canyon Dam would begin following completion of the diversion channel at Elwha Dam, as Lake Mills would be operated to maximize flood storage and minimize work stoppages at Elwha Dam. Glines Canyon Dam would be notched by saw cutting and blasting. The notches would be sized and their removal timed to allow about 7.5 feet of reservoir drawdown every two weeks. Concrete rubble and other waste would be hauled to the disposal sites described above.

The majority of sediment accumulation lies behind Glines Canyon Dam. A portion of this sediment would be eroded naturally by the Elwha River. The reservoir and river channel would be extensively monitored. The sediment release rate from the reservoirs would be controlled by controlling the rate of dam removal.

A second sediment management alternative, the Dredge and Slurry alternative, was also considered and is fully analyzed in this *Implementation EIS*. This alternative involves the use of suction dredges mounted on barges in each reservoir. Fine-grained sediment composed of silt and clay would be slurried with water and sent through a pipeline to the Strait of Juan de Fuca. From Lake Mills to Lake Aldwell, the pipeline would follow roads and the river channel to Lake Aldwell. It would be fixed in place in the river until it reached Elwha Dam where it would follow one of two routes to the strait: the river or county roads.

The Dredge and Slurry alternative and the proposed action (the River Erosion alternative) are referred to as the action alternatives in this EIS. A No Action alternative, or the continuation of conditions as they are now with the dams in place, was also analyzed.

The EIS Team examined many different options for removing the dams and managing the sediment behind them. The reasoning behind eliminating several dam removal and sediment management alternatives is described in the Alternatives chapter, under the section titled "Alternatives Considered But Rejected."

The EIS team also analyzed alternatives for fisheries restoration, revegetation, water quality, flood protection and land management. A summary of actions required or considered to restore, protect, or manage these resources follows.

A variety of measures would be used to help restore the Elwha's salmon and anadromous trout and char. Some of these measures include the use of hatcheries to develop and maintain broodstock, outplanting eggs, fry and smolts by tank truck, helicopters and other means, the use of acclimation ponds in the river, and harvest management (i.e. fishing restrictions). Because the Lower Elwha Tribal Fish Hatchery is needed to accommodate the restoration effort, as well as to protect broodstock during dam removal, it would be fitted with a larger capacity infiltration gallery and new wells located near the river.

Ecosystem restoration measures would include revegetation of land aquired by Olympic National Park at Glines Canyon damsite and the drained Lake Mills reservoir. Revegetation of the lake beds would involve some natural recolonization and a moderately intensive program of planting native species. Planting seeds, cuttings and trees of different ages would help create a more natural, structurally diverse forest ecosystem in a shorter period of time, and keep exotic vegetation from invading. This, in turn, would create wildlife habitat and habitat usable by species of special concern. The return of salmon and steelhead throughout the river would also provide a fundamental link in restoring the Elwha River aquatic and terrestrial ecosystems.

The Elwha Restoration Act (PL 102-495) requires that industrial and municipal water users experience no adverse impacts from dam removal. This group of users includes the City of Port Angeles municipal and industrial customers served from the Elwha River and the Dry Creek Water Association. The major impact to these users would be to water quality during sediment erosion. Industrial users of Elwha water would be protected by filtering water through the riverbed and collecting it in an infiltration gallery or perforated pipe buried beneath the riverbed. During dam removal, this would be supplemented with open channel pre-treatment with an approved flocculent and a temporary settling basin. The City of Port Angeles municipal supply is already

Lake Mills, Observation Point. (Maggi Johnson photo) experiencing supply problems as the river is meandering away from its current Ranney collector. A second Ranney collector on the opposite side of the river would ensure a constant supply. Treatment for iron and manganese may also be required; if so, a filter would be installed. Dry Creek Water Association could either connect to the city of Port Angeles' Ranney system or to a separate treatment facility built to chlorinate and filter its supply. These measures would protect against adverse project impacts, as well as provide additional longer term benefits to local water users.

Additional mitigation not specifically required by the Elwha Restoration Act, but analyzed by this DEIS and recommended for adoption, would protect individual well users, the Elwha Place Homeowners' Association and Lower Elwha Klallam Tribal residents from adverse impacts of dam removal to water quality or sewage treatment capacity. In addition, increases in flooding from the return to pre-dam elevations of the riverbed and water level may require elevating or otherwise protecting wellheads.

Increases in surface water elevation in some places on the river may also result in increased flooding of homes, cultural resources, or other structures in the floodplain. Building flood protection levees or dikes, or using flood insurance or other means to protect or compensate homeowners are mitigation measures considered.

Minimizing impacts to cultural resources is required by the National Historic Preservation Act. These actions are considered an integral part of both action alternatives, and include surveys, inventorying important historic properties and intensive monitoring during and following dam removal to ensure timely action to prevent or mitigate impacts.

Both action alternatives would include the acquisition of land by the federal government. Lands within Olympic National Park (those now occupied by Glines Canyon Dam facilities and Lake Mills) would be used either for wilderness recreation, interpretive opportunities, or both. Some features of the project would be left in place to help the park explain the history of the dams and their removal to visitors. Lands acquired outside park boundaries (Elwha Dam and Lake Aldwell) would be managed by either the park, the state of Washington, US Fish and Wildlife Service, and/or the Lower Elwha Klallam Tribe. Any of the four land managers would be required by the Elwha Restoration Act to leave lands within the floodplain in a natural condition to accommodate fish restoration.

Costs for each alternative are summarized in table 1 below.

A No Action alternative was also analyzed to provide a comparison for the two action alternatives. Under the No Action alternative, no costs associated with construction would be incurred unless the dams require Federal Energy Regulatory Commission licensing, in which case those costs as identified in the programmatic EIS (DOI et al.1995) to install fish passage measures and

Table 1. *Summary of Costs for Each Action Alternative (thousands of dollars)*

ACTION	RIVER EROSION	DREDGE AND SLURRY
Project/land acquisition	29,800[a]	29,800[a]
Dam removal	33,567	32,951
Road rehabilitation	528	528
Sediment management[b]		22,496
Water quality mitigation	29,770	23,987
Revegetation/wildlife	3,205	3,205
Flooding mitigation	3,998	3,998
Hazardous waste disposal	587	587
Fish restoration[c]	7,380	7,380
Cultural resources mitigation	665	665
Monitoring/modeling	2,144	1,844
Total	**111,115**	**127,441**

[a] Includes other lands and rights costs.
[b] Includes cost of slurry pipeline and dredging, all other sediment management costs for both included in monitoring/modeling.
[c] Includes hatchery expansion, operation and maintenance.

other upgrades would apply. Some protection from flooding and water quality treatment is in place now. These measures include large levees on both the east and west side of the river near the mouth, filters to treat water used by the Daishowa and Rayonier mills and underground collection and chlorination of municipal water used by the city of Port Angeles.

Summary of Impacts

Fluvial Processes and Sediment Transport

The natural transport of sediment has been blocked by the dams. As a result, about 8.5 million cubic yards of larger-grained or coarse sediment (sand and larger) and 9.2 million cubic yards of fine-grained (silt and clay-sized) sediment has accumulated in the reservoirs.

Under the proposed action (the River Erosion alternative), between 4.8 and 5.6 million cubic yards of fine-grained sediment (silts and clays) and between 1.2 and 2.6 million cubic yards of coarse-grained sediment (sand-sized and larger), or less than half of the sediment now stored in the reservoir lake beds and deltas, would be naturally eroded by the Elwha River. Successive filling and draining of Lake Mills during dam removal would help move the materials toward the dam face so they could be eroded downstream.

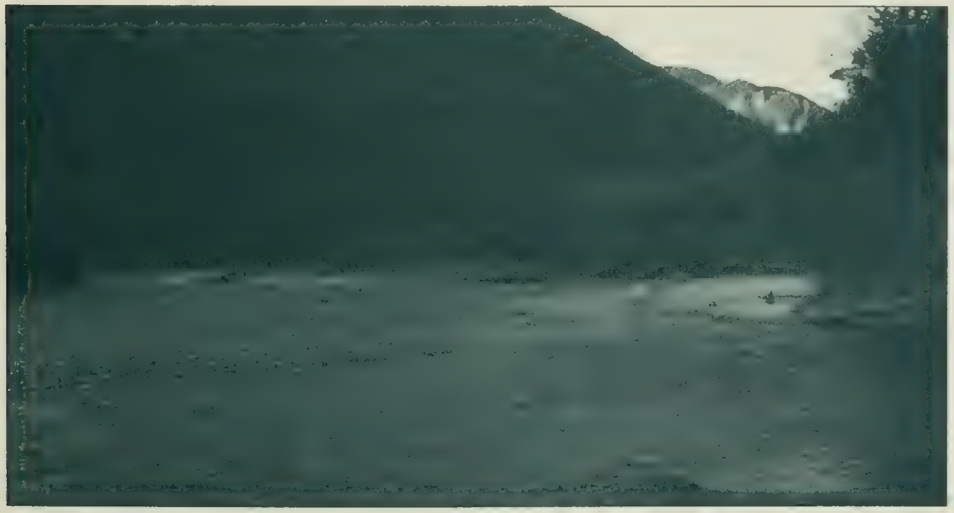
In the Dredge and Slurry alternative some of the fine-grained sediments would be removed by pumping them with water through a pipeline to the Strait of Juan de Fuca. This process would remove an estimated 75% of the silt and clay which would otherwise enter the river during dam removal. Instead of the 4.8 to 5.6 million cubic yards of fine-grained sediment that would erode from the reservoirs with the proposed action, 1.2 to 1.4 million cubic yards would wash into the Elwha River during dam removal and for the following 6 months.

Sand and gravel which formed the riverbed before the dams were built has eroded out to sea, resulting in a lowered or degraded river channel below the dams. This section of river channel is also "armored" with larger rocks (cobbles and boulders) and so moves at high river flows. The loss of riverbed material has severely degraded anadromous fish habitat, allowed vegetation to become firmly established on gravel islands and floodplains, and has reduced natural river meandering and lowered flood stage. This in turn has curtailed the formation of slower moving side channels, periodic wetlands or riparian areas.

Removing the dams and allowing sediment to erode would return sediment, including spawning gravel, to the river downstream and restore the river's natural river meandering and flood stage. Reestablishing the natural sediment load to the river would cause the river to aggrade and the water surface elevation to rise in some places. Vegetation which has grown in the floodplain may restrict the river's flow, and may be washed away by scouring as the riverbed returns to pre-dam conditions. These changes would occur with either the River Erosion or Dredge and Slurry alternative.

Flooding

"Aggradation," or the increase in riverbed elevation and associated increase in water surface elevation after dam removal, would be more pronounced in relatively flat areas. Modeling indicates aggradation would likely increase



Elwha River.
(Curtis Miller photo)

over time, and would increase water surface elevations by as much as 1 to 4 feet in some spots on the river, but would average 2 feet.

Many of the homes, wells or cultural resources which would be affected are already in the 100-year floodplain and susceptible to flooding. Mitigating measures which would provide the present level of flood protection were examined; a description is located in the Impacts to Flooding section. At this time, raising and strengthening the Lower Elwha Federal Flood Control Levee and measures to protect municipal and/or industrial water users are fully integrated into both action alternatives. Other mitigating measures are not required by a specific law but are recommended to protect downstream residents and structures.

Surface Water

The reservoirs have affected water quality by acting as a large settling basin during floods, landslides or other events which would normally produce surges of turbidity downstream. During these events, a "slug" of sediment moves slowly through the reservoirs, which dampens peak turbidity levels downstream but extends them over a longer period of time. Turbidity during floods is therefore less intense but longer lasting because of the reservoirs. Removing the dams would reduce the longevity of turbidity events, but increase peak levels.

Surface water users would, for the most part, not be affected in either the short or long term by dam removal...

The dam removal process would also greatly increase turbidity(from a maximum of about 800 nephelometric turbidity units (NTU's) now to as much as 25,000 NTUs) for short periods of time (a few days), suspended sediment and possibly dissolved manganese and iron stored in reservoir sediments for the one to two-year period during dam removal. Using suction dredges to remove up to 75% of the fine-grained sediment would reduce peak turbidities to a maximum of about 10,000 NTUs for one to three day periods during dam removal. These are major adverse impacts to surface water quality. Minor changes to pH, temperature and dissolved oxygen would also occur during dam removal.

In the two to six years after dam removal, turbidity, suspended sediment and dissolved iron and manganese would settle to levels slightly to moderately higher than under conditions now. Turbidity would range up to 1000 NTUs, suspended sediment would average 69 ppm, dissolved iron 20–2,300 micrograms per liter, and manganese 10 to 700 micrograms per liter. Increased suspended sediment and turbidity would have a long-term moderate adverse impact on water quality; increased iron and manganese a long-term minor impact. Water temperatures would be decreased in late summer and fall as a result of dam removal. This would be a major beneficial impact to water quality and aquatic life. Changes in pH and dissolved oxygen would have negligible or minor impacts to water quality.

Surface water users would, for the most part, not be affected in either the short or long term by dam removal, as mitigation to protect them against adverse impacts of the action is required. An infiltration gallery and open-channel industrial pre-treatment would be used to treat surface water before serving the City of Port Angeles' two largest industrial customers, the Daishowa America and Rayonier mills. The third user of this water, the Washington Department of Fish and Wildlife fish rearing facility, would be closed during dam removal and chinook salmon production moved to another facility. However, the infiltration gallery would stay in place following dam removal and water collected in it would also supply the rearing facility when it reopens.

Groundwater

Groundwater users would be affected by changes to the river as a result of the dam removal process. Infiltration of fine sediments into riverbed substrate or through well screens would increase turbidity and/or decrease yield from the aquifer. Increased bedload of the river would promote renewed channel migration and bank erosion, which might affect yield. Riverbed aggradation would increase river stage, and wells might be overtopped and contaminated. Mitigation measures for Port Angeles, Dry Creek Water Association, and the Lower Elwha Tribal Fish Hatchery are mandatory and would effectively eliminate impacts of dam removal to these users.

A new Ranney collector installed on the opposite side of the river and upstream from the one which exists now would ensure uninterrupted and high quality municipal supplies for the City of Port Angeles. The Dry Creek Water Association (DCWA) could either connect to the Ranney well supply, or require a separate filtration and chlorination facility. Either would protect DCWA users from the adverse impacts of dam removal.

Several other users of Elwha River water, including Elwha Place Homeowners' Association (EPHA), individual well users and some residents of the Lower Elwha Klallam Reservation would experience adverse impacts during dam removal. Mitigation measures to protect each are analyzed in this DEIS and recommended for adoption. The proposed mitigation for individual well users is described in Impacts to Groundwater section. It includes raising wellheads, installing in-line filters and temporary storage tanks, drilling to deepen existing wells or create new ones, and a contingency fund. The Elwha Place Homeowners' Association might experience increased turbidity, dissolved iron or manganese and overtopping of their wells as a result of dam removal. Modifying wellheads, flood-proofing the pump house, and installing a temporary water treatment system would protect EPHA from any adverse impacts of dam removal. Without mitigation, these users could experience minor to major impacts from dam removal.

Several residents of the Lower Elwha Klallam Reservation would experience higher groundwater levels, rendering their septic systems unusable following dam removal. A mounded system with lift stations would resolve this impact. Non-structural solutions to resolve flooding and/or water quality problems might also exist.

Chinook salmon spawning behavior in the lower Elwha. (Natalie Fobes photo)

Native Anadromous Fisheries

The dams and their reservoirs have directly affected salmon and seagoing trout by blocking access to all but the lowest 4.9 miles and by inundating 5.3 miles of what once was high-quality habitat. Salmonids are restricted by the dams to the lower 4.9 miles of river, and the problems associated with crowding into this space are exacerbated by the near-elimination of spawning gravel and by the higher-than-normal water temperatures that are present during some months — both of which are caused by the dams and reservoirs. Also, many species require slower moving water, riparian vegetation, or a fully functional estuary to spawn or rear, all which have been reduced by the elimination of natural sediment transport. The number of native anadromous Elwha spawning salmonids has dropped from an estimated 380,000 (or more) to fewer than 3,000 today (1995). Existing stocks in the lower river unsupported by artificial propagation (hatchery operations) would likely decline to extinction under the No Action alternative.

Existing stocks in the lower river . . . would likely decline to extinction under the No Action alternative.

Removing the dams and draining the reservoirs would restore natural sediment transport, add 5.3 miles of riverine habitat, make accessible the entire 70+ miles of river the fish used before the Elwha Dam was built, and restore high quality habitat in the lower and middle reaches of the Elwha River. Estimates of the approximate number of each of the five salmon species (representing six runs, or stocks) and steelhead trout (representing two runs) which would return under these conditions, and the time to recovery assuming no hatchery intervention, are presented in table 2 below. For comparison, estimates of the number of wild production of each species occurring in the river now (i.e. No Action) are also included.

Table 2. *New Wild Salmonid Production and Recovery Time*[a] *(number of fish/year)*

	ACTION ALTERNATIVES (FULL RESTORATION)		NO ACTION[b] (EXISTING CONDITIONS)
	Number of Fish	Years to Recovery	Number of Fish
Chinook	31,000	21-25	1500-2000[c]
Coho	35,000	15-18	<500
Chum	36,000	18-21	<500
Pink	274,000	16-20	<50
Steelhead	10,000	15-18	<500
Sockeye	6,500	12-20	0

[a] Assuming no outplanting or hatchery production. Outplanting may reduce recovery time by as much as half.

[b] No Action (existing conditions) would not result in any new wild salmon or steelhead. These figures are estimates of current production of wild anadromous fish in the Elwha River.

[c] All Elwha chinook are considered a composite of wild and hatchery stocks.

Short-term Impacts

The release of sediment downstream during the two-year dam removal process would have major adverse short-term impacts on salmonids attempting to return to or spawn in the river. Most of these are hatchery fish which support commercial or sport fisheries, although some native fish do return and would be used as stock to restore Elwha runs.

The most pronounced effects of dam removal in the short term would be on adults. Since few, if any, adults entering the river to spawn during dam removal would be successful, egg or juvenile mortality would only be indirectly affected.

Adult summer/fall chinook begin their upstream migration in July and spawn in September and October. They would be most severely affected during the initial reservoir drawdown beginning in June of the first year, as well as by the complete dam removal work which begins in July of the second year and lasts through October. Some adults would enter the river and be killed by suspended sediment loads, and some would avoid the Elwha and stray into neighboring rivers during these periods. Although the same species would be affected in the same way under both the River Erosion and Dredge and Slurry alternatives, the degree of impact would be less if the bulk of the fine suspended sediment is removed first (as proposed with the Dredge and Slurry option).

Elwha sockeye salmon are considered extinct, and would be restored following dam removal using related stock from Lake Sutherland or a neighboring river.

They are therefore not expected to experience any adverse impacts from dam removal.

Work would be stopped twice during dam removal because of flood flows and to accommodate spawning periods for several species of anadromous fish. For 20 to 85 days beginning in November, work would stop and suspended sediment loads would drop to below 200 ppm, allowing chum, coho, winter steelhead and anadromous cutthroat trout to enter the river to spawn. Some of these adults would be captured and used to further restoration efforts. Work would again be stopped in April or May and continue for 80 to 100 days and suspended sediment would then drop to below 200 ppm (i.e. background levels). Spring chinook and summer steelhead adults would be able to enter the river and spawn during this period, although adults may be captured and used to help restoration efforts. During dam removal, some outplanting of eggs or fry in the reaches of the Elwha upstream of the reservoirs is anticipated. Juveniles resulting from these outplants would be able to migrate downstream following the completion of dam removal.

Vegetation

The dams and reservoirs cover a total of 715 acres, 684 of which were inundated by the reservoirs. This acreage includes more than 5 linear miles and 534 acres of low elevation riparian communities and natural wetlands, which are important in the cycling of water, nutrients, sediment, organic matter and aquatic and terrestrial organisms in the riverine ecosystem. Wetlands and riparian vegetation also reduce the severity of flood events, act as a buffer to pollution sources entering the river and provide important fish habitat.

Full vegetative recovery would take up to 100 years, assuming all measures identified in the Revegetation Plan (appendix 3) are implemented. Within 3 years, vegetation would begin to appear natural, and be stabilized enough to mimic pre-dam levels of erosion within 6 to 10 years.

Restoring habitat would be a major, beneficial impact to most local wildlife species.

Wildlife

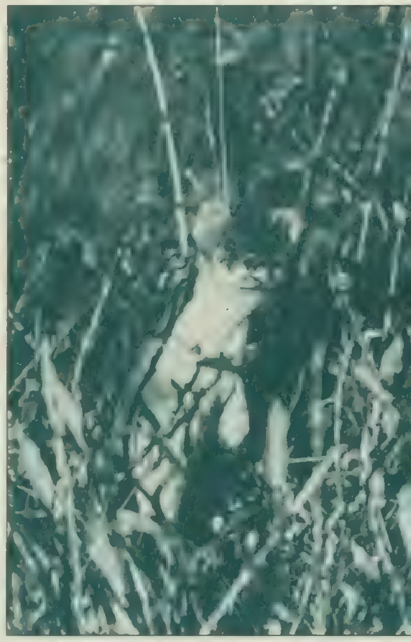
At least 22 wildlife species are known to feed on salmon carcasses, eggs or juveniles in rivers in this region. The dams eliminated this source of food for these species from all but the lowest 4.9 miles. In other river systems in the Pacific Northwest, interactions between anadromous fish and terrestrial wildlife communities are central components of ecosystem function, and therefore of the maintenance of regional biodiversity. In the Elwha, it is estimated that salmon and steelhead would bring more than 800,000 pounds of biomass and 13,000 pounds of the essential nutrients nitrogen and phosphorus to the aquatic ecosystem if the dams were removed and natural ecosystem conditions fully restored. Restoring habitat would be a major, beneficial impact to most local wildlife species.

Species of Special Concern

The primary impact of the dams to species of special concern (threatened, endangered or rare) has been loss of habitat, although some have been affected by the loss of salmon as a food source. The bald eagle is an example of the latter.

Removal of the dams and recovery of the river's ecosystem would result in major beneficial impacts to the northern spotted owl, marbled murrelet, Pacific fisher, harlequin duck, bull trout, Vaux's swift, pileated woodpecker and several rare amphibian species.

Dam removal would adversely affect some species in the short term, primarily through construction noise. Murrelets and spotted owls may avoid the area if noise gets too loud. Surveys to date have shown no murrelet nests close to the damsites, but two consecutive years of data collection are required to fulfill US Fish and Wildlife Service procedures. If 1996 surveys confirm that there are no nests near the sites, mitigation would not be required. If they find nearby nests, mitigation including noise reduction or changes in the sequencing and timing of construction activities would be developed. Spotted owl surveys to date have not found nests near either dam, with the closest being nearly one mile from Glines Canyon Dam. As a result, adverse effects on northern spotted owls are not expected.



Long tailed weasel — a species that feeds on salmon carcasses. (Janis Burger photo)

Living Marine Resources

Different species of marine life now occupy the nearshore area by the Elwha River mouth than before the dams were built. This is largely due to substrate changes resulting from the elimination of natural sediment transport. Before the dams were built, it is likely that the substrate sizes were mixed and supported species like Dungeness crab, littleneck, butter, horse and geoduck clams, sand lance, surf smelt, eelgrass, and species of green algae. These species are expected to return following dam removal.

Substrate is now composed of large-sized material (cobbles, boulders, etc.) and supports kelp, rockfish, greenling, red rock crab, and chitons. This community of marine life would sustain moderate adverse impacts during dam removal as sand and gravel bury organisms, and silt and clay make the water turbid. Over the long term, the increase in transport of sand and gravel would result in a major change in the substrate composition and associated biological community between the river mouth and the eroding bluffs to the east. Future conditions, however, would approximate those that existed prior to dam construction. This is true of both action alternatives. The Dredge and Slurry alternative would send less suspended material offshore via the river, and would instead deposit it in offshore waters 60 to 100 feet deep. This location is preferred because currents are strong and would quickly disperse fine sediment, and reduce adverse impacts to marine life.

The return of natural sediment transport would help to restore beaches, which have become steepened in part because of the loss of sand from the Elwha River, and would help offset erosion of Ediz Hook.

Air Quality and Noise

Construction activities during dam removal would send minor amounts of traffic-related pollutants (i.e. ozone, carbon monoxide, sulfur dioxide and oxides of nitrogen), and some particulates into air in the immediate area. Other sources of particulates in the Elwha basin include burns, pulp mill emissions, vehicles and campfire smoke, all of which affect visibility.

Construction-related sources of particulates would include the use of haul roads, loading and dumping, bulldozing, saw cutting, blasting and wind erosion of the exposed reservoir basins. Emissions of particulate matter less than 10 microns (PM_{10}) from these sources at Elwha Dam are expected to be about 105.3 tons, and at Glines Canyon Dam, about 25.2 tons over the 18-month to 2-year dam removal time period. Although impacts would be temporary, dust along a portion of the dirt road entry into the Elwha damsite may moderately affect homeowners in the short term and require mitigation, such as spraying periodically with water, or paving the road.

Slightly greater particulate emissions are expected under the Dredge and Slurry alternative, as the pipeline would be buried for part of the route. This would entail digging and burying, which would send dust into the air. The amount is small enough that no measurable difference between the two alternatives is expected.

There are no homes or wildlife of special concern closer than 0.3 miles to either damsite. Twenty residents live within 0.6 miles of Elwha Dam, 55 within 1.2 miles and 491 within 3 miles of the site. Other than an employee residence at the dam, the closest homes to Glines Canyon Dam are 2 miles away, and four lie within a 3-mile radius. Nests of species of special concern (marbled murrelets and/or Northern spotted owls) have been located 1 mile from Glines Canyon Dam, and 1.2 miles from Elwha Dam.

Continuous noise levels from construction equipment could have short-term (18 months to 2 years) minor adverse impacts on residents living within one-half mile of the Elwha Damsite, but would not be noticeable beyond 1.2 miles. Ambient weather conditions and topography may reduce noise levels. Species of special concern would not be affected.

Residents within 0.6 miles of Elwha Dam would periodically experience short durations of acute noise from intermittent blasting similar in intensity to that of moderate thunder. Residents and wildlife beyond 1.2 miles would not be expected to experience blasting noise; predicted noise levels during the worst-case atmospheric conditions are all below or close to 120 decibels. Both continuous and acute noise levels would be temporary and are considered negligible impacts.

At Glines Canyon Dam, pre-splitting and blasting during notching of the dam would produce about the same level of noise as at Elwha Dam, and would be the loudest actions at the site. At a distance of 1 mile from the site, sound levels would have dropped to those comparable to distant thunder or lower. At two miles, the distance of all residences except the one at the dam, the sound has no effect.

Actual noise levels could be up to 20 decibels less than those predicted due to attenuation provided by trees and terrain that were not considered in this assessment.

Traffic noise would be comparable to a logging truck and would occur primarily along routes already used frequently by such trucks.

Cultural Resources

The hydropower projects have become historic properties and both are on the National Register of Historic Places. Removing them would mean the loss of the projects themselves, a major adverse effect under the National Historic Preservation Act. However, mitigation in the form of documentation of their properties to the standards of the Historic American Engineering Record would offset this loss. Also, some features of the Glines Canyon damsite would be left in place so that Olympic National Park could use them as a focus of interpretive activities in the future. Because of these measures, the significance of the resources would be preserved, and impacts for the purposes of this EIS (i.e. under NEPA) would be reduced to minor.

Elwha Dam.
(Charles Scott photo)

The damming of the river has had a profound effect on the cultural resources of the Elwha Klallam people. The Elwha Klallam have lived in and around the river valley for thousands of years, and their culture, spiritual traditions, and economy have become intermeshed with it and the resources it has traditionally provided. These resources include the salmon and steelhead which filled the river before the dams were built.

When the river was dammed, the quantity of fish in the river drastically declined. Cultural resources important to the Lower Elwha Klallam, including the site on the river where they believe their people were created, were inundated or made inaccessible by the reservoirs or buried by the dams. The damming of the river itself has had a major adverse impact on all of the cultural resources that a free-flowing river represent to the Elwha Klallam. Only removing the dams would return these resources — the natural flowing river, the abundant salmon and trout, and the irreplaceable cultural resources which lie along the river valley. This would be a major beneficial impact of the proposed action.

Removing the dams could adversely affect some historic sites, because the river is expected to both meander and experience an increase in flood stage over what it does now. Particularly at risk are those sites such as the Elwha Ranger Station Historic District and the Altaire and Elwha campgrounds' kitchen shelters which have been built in the floodplain since the dams were constructed. These same resources may be affected by road widening or staging for construction as well. Minor impacts to cultural sites may occur as a result of rubble disposal.

The agencies cooperating in the production of this DEIS, as well as other agencies, have signed an agreement which prescribes monitoring and mitigation for impacts to cultural resources. The types of mitigation include surveys, avoidance, and documentation of the features of a resource if it will be affected. Because of the mitigation spelled out in the agreement, adverse impacts to cultural resources would be minor.

The proposed action and the Dredge and Slurry alternative are expected to have similar impacts to cultural resources, except for those potentially caused by trenching to lay the pipeline if it follows an alignment along county roads. With mitigation, these additional adverse impacts to cultural resources would be minor.

Socioeconomics

The economic benefits of dam removal far exceed the costs. Marked benefits would be derived from additional recreation, tourism, and sport fishing expected in the area after the dam removal, totalling $164 million over the 100 years of project life (at a 3% rate of discount). While data underlying nonmarket estimates of value are more variable than market estimates, the nonmarket value of restoring the Elwha River salmon and steelhead fisheries and returning the ecosystem to its natural state has been estimated at $3.5 billion per year over ten years (Loomis 1995).

The economic benefits of dam removal far exceed the costs.

Activity associated with the removal of the dams would generate between 1,150 and 1,240 jobs in Clallam County during the approximate 10 years of pre-construction, construction and restoration involved in implementing the project. This, in turn, would generate an estimated $60-$65 million in business activity and another $32 to $34 million of personal income locally. After restoration is complete, 446 permanent jobs and a corresponding annual payroll of $4.6 million would be generated in the Clallam County recreation and tourism sector. Increases in the workforce are not expected to generate any significant change in the need for public services.

The proposed action is estimated to cost $111.1 million, and the Dredge and Slurry Alternative, $124.4 million. These cost estimates may decline at final design stages.

Public Health and Safety

Three variables: overall dam safety, potential for damage due to earthquakes and impacts from hazardous materials were analyzed. Although Glines Canyon Dam is considered strong enough to withstand even a probable maximum flood or major earthquake, a recent Department of the Interior pre-acquisition inspection of Elwha Dam noted such "remotely occurring events" may cause "a dam deficiency" (DOI et al. 1995). The probability of an earthquake on either shallow crustal faults in the area or deeper subduction faults is unknown, but is probably remote. Because damage to downstream residents in the event of dam failure would be great, the dams are rated as having high hazard potential.

Special care would be taken during the removal of the Elwha Dam to ensure there is not a failure from the dam foundation as occurred during its construction in 1912. A series of cofferdams and other measures are integrated into the removal design to ensure public health and safety during dam removal.

Asbestos, PCBs, and chemicals such as fuels, paints, lubricants, and pesticides were found in the project area. These are contained in soil, transformers, wiring, associated buildings, and batteries at both powerhouses. The areas would be cleaned up by remediating and removing the contaminated materials from the dams and associated buildings and transporting them offsite to a licensed hazardous waste dumpsite under either action alternative.

Traffic

Impacts to traffic would occur as a result of trucks carrying equipment and personnel to and from the site, and carrying rubble and waste materials away. They would last only during the construction period, and would peak during the final 7 months of Elwha Dam demolition.

Nine different waste disposal areas were analyzed. Traffic information generated for 13 major intersections through which trucks would need to pass was also assessed. The addition of project traffic would cause only one intersection to decline in its level of service (LOS) rating during peak hours. Two construction years were analyzed, 2000 and 2005. Assuming the maximum number of trucks entering and leaving the Elwha Damsite (16 trips per hour — 8 each way) during the year 2005, the intersection rating of US 101 and SR 112 would fall during the peak traffic hour from LOS B to LOS C. This means the time spent stopped or delayed at the signal at this intersection would increase from a range of 5 to 15 seconds up to a range of 15 to 25 seconds. This impact is minor and temporary.

Impacts from project traffic to all other intersections during peak hour traffic on both weekends and weekdays would be negligible.

There may be concerns about truck traffic entering the highways from the site access points at Power Plant Road and Olympic Hot Springs Road. As a safety measure, flaggers may be used at these intersections to facilitate the introduction of trucks to the busy arterial roadways.

Indian Trust Resources

Glines Canyon Dam. (Charles Scott photo)

The dams have harmed resources secured to the Elwha Klallam and other tribes under the Treaty of Point No Point, and the Treaty with the Makah, signed in 1855. Under these treaties, tribes retained the right to take up to one-half of the harvestable fin and shellfish returning to usual and accustomed fishing places (except for "staked or cultivated beds"). The dams have reduced the number of harvestable fish to near zero (without hatcheries, all native anadromous runs would likely eventually die out), and greatly reduced both sandy substrate and the Elwha estuary beneficial to shellfish. Both of these impacts are major and adverse, although impacts to shellfish have not been quantified.

In addition, the federal government is obliged to protect Indian trust or restricted lands in the Elwha River drainage. The near-elimination of sediment transport beyond the dams has resulted in major erosion of tribal beaches. Also, the risk of failure of Elwha Dam (from very large earthquakes or floods) is unknown, but considered unacceptable by the tribe at this time until further safety analyses are completed.

Removing the dams and draining the reservoirs would restore conditions under which fish and shellfish would flourish, eliminate the risk of Lower Elwha Klallam Reservation flooding from dam failure, and reverse reservation beach erosion. Either action alternative would uphold the federal trust responsibility, and have major beneficial impacts to resources subject to it. The No Action alternative would continue major adverse impacts to these same resources and would not uphold the federal trust responsibility.

Recreation

Local residents use both reservoirs for fishing and boating and the loss of this recreational resource would be a major impact to them. Nearby lakes, such as Lake Crescent and Lake Sutherland, are expected to accommodate users from Lakes Aldwell and Mills, and would be slightly more crowded as a result. Out of town visitors would only experience a minor impact because of the availability of other lakes in the area.

During construction (about two years), the Elwha subdistrict of Olympic National Park would be closed to visitors. This would impact an estimated 140,000 (1993) to 170,000 (1994) visitors using the Elwha River valley inside the park each year, including hikers, campers, sightseers, picnickers, fishers, boaters, horseback riders, and backpackers. Shuttle service in the valley would mitigate some of this impact. Restrictions on sport fishing during dam removal and restoration of native anadromous salmon and trout may adversely affect both marine and in-river recreational fishers for up to a decade or more in some cases.

In the long term, both the River Erosion alternative and the Dredge and Slurry alternative would increase river recreational opportunities and would have a major beneficial impact on salmon and steelhead sport fishing in the Elwha River valley and Clallam County.

Land Use

Use of lands associated with the Glines Canyon hydropower project is inconsistent with policies governing land use inside Olympic National Park. These policies are designed for lands either designated as wilderness or that are in a relatively natural state. When the dams are removed, the park would maintain some features of the damsite for their interpretive value but otherwise the land would be revegetated and managed for backcountry / wilderness uses. This would conform with National Park Service policies and would be a permanent beneficial impact. The objectives of several regional and local land use plans would also be achieved.

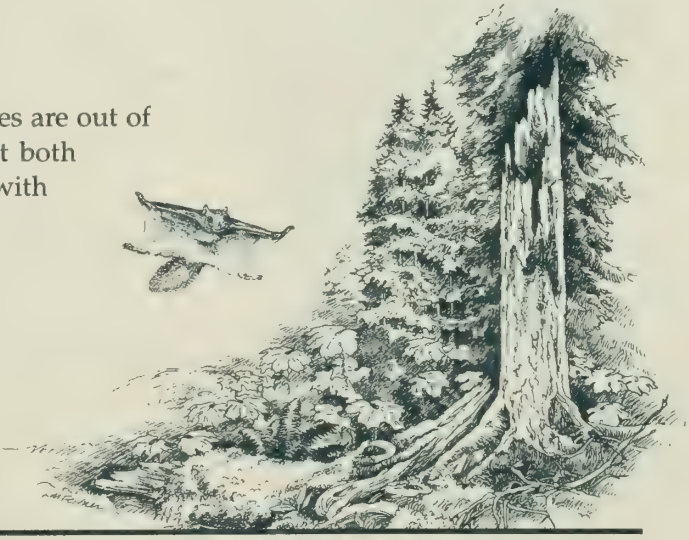
Lands associated with the Elwha hydropower project are outside park boundaries and are designated by the Elwha Restoration Act to revert to one of four managers. Two of these (the US Fish and Wildlife Service and the Washington Department of Natural Resources) are not interested in acquiring and managing the lands, particularly if access to the river is maintained. The third, Olympic National Park has stated the lands qualify for inclusion in the park, but is not pursuing their inclusion in the park. The fourth party, the Lower Elwha Klallam Tribe, is interested in managing the lands and has proposed some use of the lands away from the river for natural resource management, housing, and / or economic development. Any land manager is required by the Elwha Restoration Act to protect fisheries and ecosystem restoration.

Disposing of over 210,000 cubic yards of concrete and fill materials and 730 tons of mechanical and electrical equipment from the demolished dams would permanently commit land to this use, but may reclaim sites unusable now (such as surface gravel mines).

Aesthetics

The dams and associated hydropower facilities are out of character with the surrounding landscape at both sites, and contrast in form, color and texture with that landscape.

Removing the dams and draining the reservoirs would expose two large, flat expanses visible to visitors and/or passengers along Highway 101. Dust from the lakebeds would impair visibility during windy days until vegetation takes hold (the



year after the reservoirs are drained). As time passes, vegetation would become more varied and the area would eventually begin to appear natural. If shorelines and other upland areas are revegetated as proposed, the sites would return to the climax forest stage within several decades.

Purpose and Need

Previous page: Waterfall in the Elwha River valley. (Jesse Thomas collection, Seattle Art Museum photo, courtesy of Rod Slemmons)

Workmen standing in the forms of the Glines Canyon Dam under the cement chute. (Daishowa/James River Company photo)

Purpose and Need

Introduction

In the early 1900s, the free-flowing Elwha River on the Olympic Peninsula in Washington State was blocked by two hydroelectric dams (see figure 2). The Elwha Dam was built, beginning in September 1910, 4.9 miles from the mouth of the Elwha River. It impounded the reservoir known as Lake Aldwell. Construction on Glines Canyon Dam, 8.5 miles farther upstream, began in 1926, creating the reservoir known as Lake Mills. Built without fish passage facilities, the dams blocked the upstream migration path for all species of native anadromous salmon and trout that had used the river for spawning and rearing. They also interrupted the downstream movement of sediments (gravel, sand, etc.) needed for spawning and, through inundation, destroyed additional river habitat important for salmon and trout.

The dams supplied some of the first electrical power to Port Angeles and the Olympic Peninsula, and are now devoted entirely to supplying a portion (38%) of the power needs for a pulp and paper mill in Port Angeles, Washington, currently owned by the Daishowa America Corporation. In 1968 Crown Zellerbach, the owner and operator of the dams at that time, submitted an application to license the Elwha Dam and in 1973 submitted an application to relicense the Glines Canyon Dam with the Federal Energy Regulatory Commission (commission). Licensing was controversial and a number of parties challenged the commission's jurisdiction to relicense the Glines Canyon Dam, primarily because of its location in Olympic National Park.

Aerial photograph of Krause Bottom, upper Elwha River. (Bureau of Reclamation photo)

Congress responded to the controversy by enacting Public Law 102-495, the Elwha River Ecosystem and Fisheries Restoration Act, in October 1992 (see figure 3). The act both directed the secretary of the interior to study ways to fully restore the native anadromous fisheries and ecosystem of the Elwha River and suspended the licensing process. The secretary's *Elwha Report* was submitted to Congress in 1994. In it, the secretary determined that removing the dams was both feasible and necessary to fully restore the fisheries and ecosystem and to promote the federal trust responsibility for affected Indian tribes.

While the *Elwha Report* reached certain conclusions about potential river restoration, further evaluation of issues, alternatives, and potential impacts would assist the secretary of the interior in making a final decision. A full range of alternatives to the proposed removal of both dams, and the environmental impact of each alternative, were analyzed in the Department of the Interior environmental impact statement, titled *Elwha River Ecosystem Restoration* (refered to in this document as the programmatic EIS). This document was finalized in June 1995. It incorporated the *Elwha Report* by reference, and adopted large sections of a Federal Energy Regulatory Commission draft environmental impact statement (updated and retitled *Draft*

Figure 2. *Project Area*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20057B

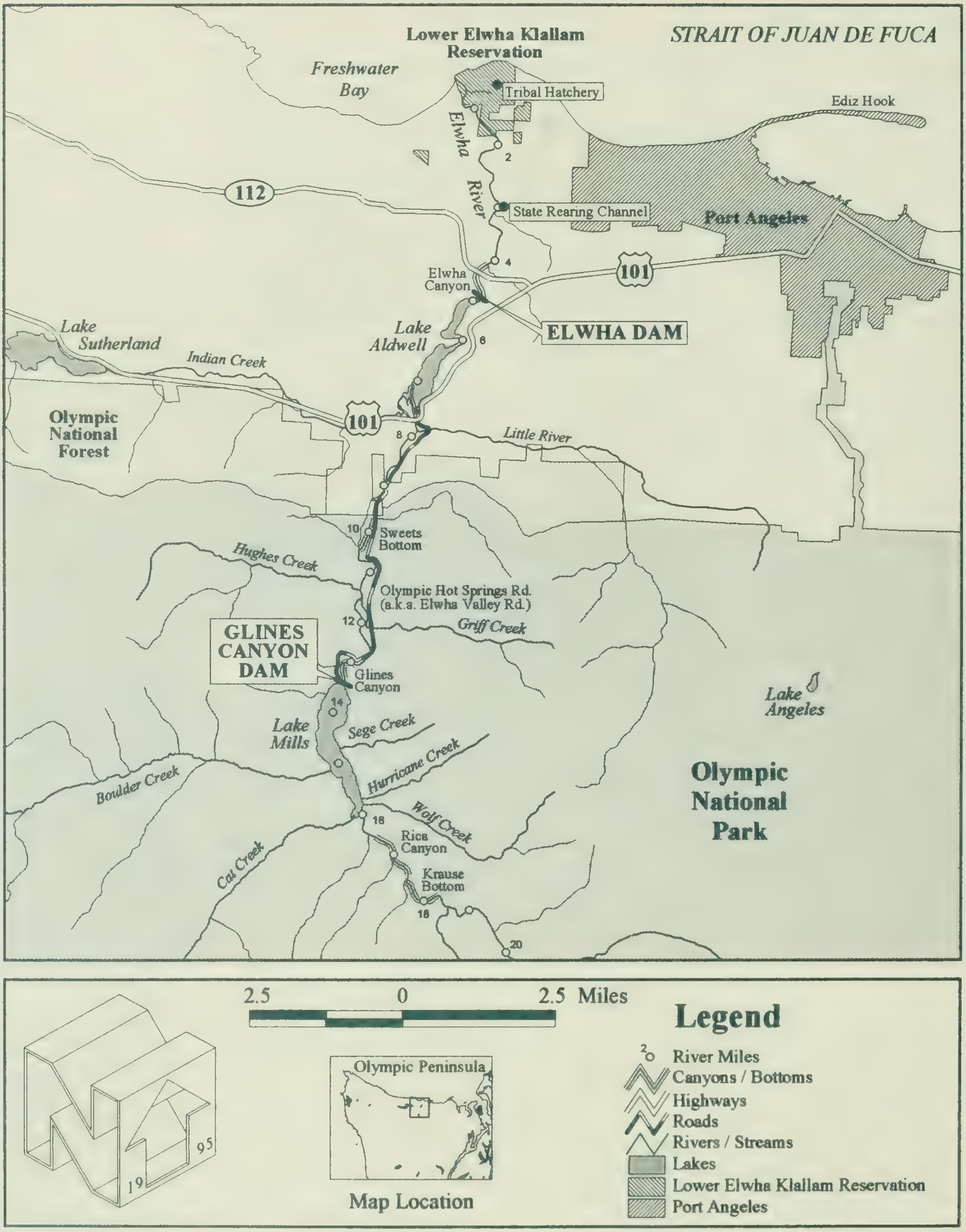
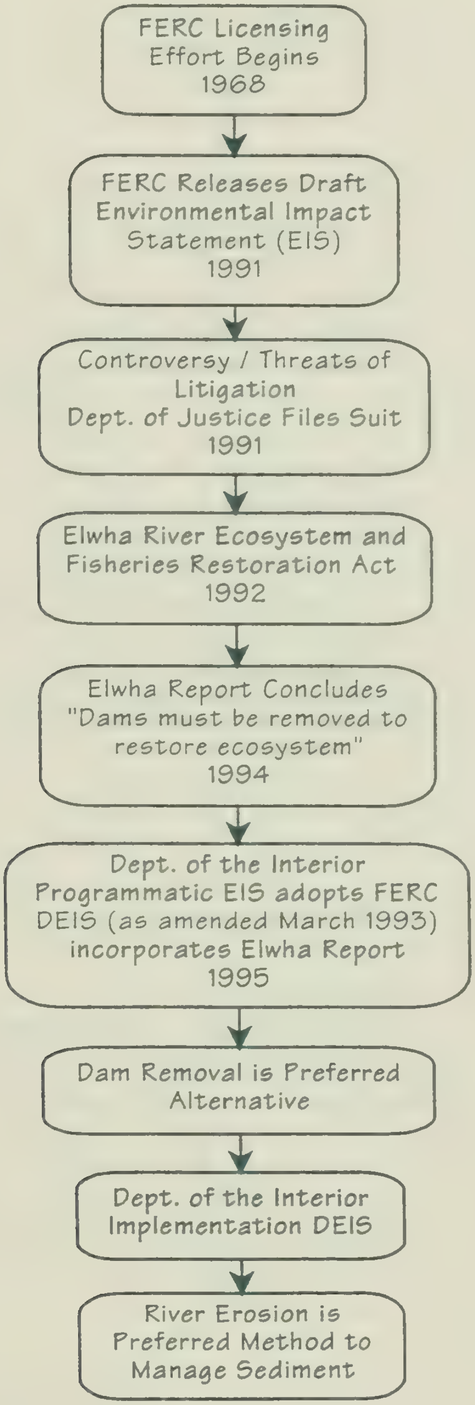


Figure 3. *Sequence of Documents and Events Leading to this Environmental Impact Statement*


FERC Licensing Effort Begins 1968
FERC Releases Draft Environmental Impact Statement (EIS) 1991
Controversy / Threats of Litigation Dept. of Justice Files Suit 1991
Elwha River Ecosystem and Fisheries Restoration Act 1992
Elwha Report Concludes "Dams must be removed to restore ecosystem" 1994
Dept. of the Interior Programmatic EIS adopts FERC DEIS (as amended March 1993) incorporates Elwha Report 1995
Dam Removal is Preferred Alternative
Dept. of the Interior Implementation DEIS
River Erosion is Preferred Method to Manage Sediment

Populations of the five species of Pacific salmon ... as well as seagoing trout such as the steelhead, have been declining over the last century, in some cases drastically.

Staff Report in 1993) prepared in review of licensing the power plants. The important information needed to make a policy decision whether to restore the ecosystem through dam removal is contained in these three documents.

To give the secretary a range of feasible options for implementing the choice of removing both dams, the Department of the Interior and cooperating agencies prepared this second environmental impact statement, referred to as the *Implementation EIS* throughout this document.

This environmental impact statement is divided into five sections. The first is Purpose and Need, which examines the existing problems the federal government is trying to solve by taking action. The second is a description of Alternatives, including those considered but rejected. The third is Affected Environment, which describes those parts of the physical, natural, and cultural environment that are either affected now (i.e., by the No Action alternative) or expected to be affected if action is taken. The fourth is the Impacts section, organized by impact topic (e.g., Fluvial Processes, Water Quality). Under each impact topic is a summary of applicable regulations and policies and a description of methods used to predict impacts. This summary is followed by a description of the impacts of No Action — i.e., the dams remain in place. Next the impacts of the action alternatives are described. First is the proposed action, referred to as the River Erosion alternative, and next is the second action alternative, Dredge and Slurry. Cumulative impacts, or additive effects of other sources of impact, are combined and summarized once under each impact topic for all three alternatives. Finally, the Consultation and Coordination section describes public involvement and preparers of this document.

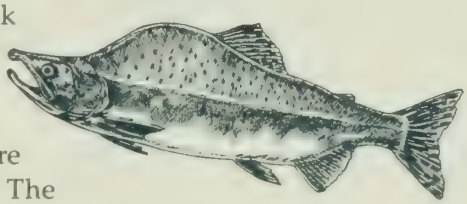
Purpose and Need for Action

Regional Context

Populations of the five species of Pacific salmon (coho, chinook, sockeye, pink, and chum), as well as seagoing trout such as the steelhead, have been declining over the last century, in some cases drastically. An estimated 30 million salmon and searun trout migrated as spawning adults from the Pacific Ocean to rivers and lakes along the United States west coast a century ago. Today the annual return is 5 to 10% of that number, with salmon and searun trout extinct in a quarter of their former range and at risk of extinction in another half. In addition, hatchery-bred salmon, which tend to be poorly adapted to stresses of the natural environment, make up 60 to 90% of the returns to western spawning streams (Sims 1994).

Many anadromous fish stocks are in trouble; the American Fisheries Society reports more than 100 Pacific salmon stocks are already extinct and 214 are at moderate or high risk. All Pacific salmon and anadromous trout are either under status review or proposed for listing as threatened or endangered under the Endangered Species Act . In the Columbia River, numbers of salmon have fallen from an estimated 16 million a century ago, to 1.2 million in 1993. This is despite extensive hatchery operations and fish passage measures at Columbia River dams.

Fewer than 2,000 adult salmon made it up the Snake River to Idaho in 1994, compared with 10 times that number as recently as four years previously. The Snake is dammed with four large dams. Snake River sockeye are classified as endangered, and two runs of Snake River chinook are threatened. In the Elwha River, biologists believe the runs of both pink and sockeye salmon are endangered or extinct. Elwha River spring chinook return only in very small numbers, if at all. Coastal coho and coastal steelhead trout are proposed for listing under the Endangered Species Act. The National Marine Fisheries Service has classified coastal coho stocks of Washington and Oregon as "threatened," while steelhead trout are still under review. Puget Sound (including those from the Elwha River) and Lower Columbia River area coho are candidate species for federal listing.



Commercial salmon and steelhead catches in the Northwest, which once topped 200 million pounds per year, fell to 61 million pounds in 1988, yet the industry still supported 60,000 jobs and $1.25 billion in commercial and sport fishing income. Now, annual catches are only an estimated 20 million pounds (Satchell 1994). The decline prompted an unprecedented move by the Pacific Fishery Management Council to completely ban salmon fishing off the coast of Washington and set strict limits on commercial and recreational fishing off Oregon and California in the spring and summer of 1994. Washington ocean fishing for chinook continued to be severely restricted in 1995, and a low quota (130,000) for Washington coho was set. In conjunction with these actions, federal fishing "disaster relief" money ($15.7 million in 1994) was dispatched by congress to aid fishing-dependent communities.

The causes for the decline are numerous. In some cases, it is overfishing. Conditions in the marine environment, such as the warm water current known as El Niño, may also affect populations on a large scale. Destruction of freshwater habitat that fish require for spawning also has been a dominant factor in reducing or eliminating runs. In streams, increased sediment loads from logging, dredging for gold, and from the building and use of roads coats and smothers eggs. Logging to a river's edge eliminates streamside vegetation essential for successful hatching or rearing for some species. Dams affect habitat by holding back necessary spawning gravel, altering flow patterns, and inundating stream habitat. Reservoir water released over the spillways is often too warm and has too little oxygen or too much nitrogen — conditions that lead to disease or death in downstream fish populations. Water diversions for municipal, industrial, and agricultural use can limit downstream spawning and add pesticides or other pollutants that stress fish. The crowded and unnatural conditions in most hatcheries are associated with disease and produce fish ill-adapted to the natural environment. On the Columbia-Snake system, losses associated with the fish passage measures and the dams and reservoirs are considered responsible for the low returns of salmon and steelhead. The dams kill 85 to 95% of migrating smolts on their way to sea, and between 34 and 57% of adults returning to spawn (Sims 1994). This is despite an estimated $1.5 billion spent over the last 13 years to implement fish passage measures (Satchell 1994).

Elwha River

Most of the habitat of the Elwha River is in excellent condition, because 83% of the watershed lies within Olympic National Park and is managed to maintain natural conditions. This is unusual, because most rivers in the western United States are either highly developed along their banks or their water is heavily used and often polluted. In contrast, water in the Elwha is considered Class AA, of "extraordinary" quality, by the state of Washington.

However, for more than 80 years, the Elwha Dam has prevented passage of the Elwha River's 10 runs of salmon and anadromous trout beyond the first 5 miles of river. In addition, both dams prevent the natural transport of gravel, sand, and other sediment downstream, rendering the lower 13.5 miles of the river largely unusable for spawning fish. This stretch of river is also unnaturally heated in late summer and early fall, because surface releases from the reservoirs raise the temperature of the stream. The water is largely devoid of the organic debris and minerals it once contained from salmon carcasses decaying upstream. This has reduced productivity, including that of insects and aquatic invertebrates that serve as food for the salmon and trout. Although

Elwha River — Island Camp, May 27, 1907. (Asahel Curtis photo, Washington State Historical Society) the Elwha River once supported an estimated 300,000 to 400,000 wild salmon and seagoing trout annually, fewer than 3,000 return today. Instead of occupying 70 miles of high quality river, populations of mostly hatchery fish crowd in the lower 4.9 miles, where they exist in unnatural and poor conditions.

Through the elimination of salmon in the middle and upper river, the dams have altered the Elwha River aquatic and upland ecosystem as well. The hundreds of thousands of salmon and trout that once occupied the river served as a year-round dependable food source for at least 22 species of wildlife. Salmon carcasses contribute as much as 40% of the body weight of aquatic insects and small fish in spawning rivers (Sims 1994); these are near the bottom of an extensive food chain connecting the river and land-based ecologies.

Lake Mills from Glines Canyon Dam.
(Maggi Johnson photo)

The reservoirs have flooded more than 5 miles of stream and riparian vegetation and the dams have held back natural sediment transport. This has fundamentally altered the river morphology and "armored" the remainder of the Elwha riverbed downstream of Glines Canyon Dam. Gravel and sand once occupied the riverbeds and provided habitat for insects, aquatic species, and spawning salmon. The higher natural sediment loads made the river more dynamic; river channels changed locations and vegetation was scoured from banks and floodplains. Now, well-vegetated islands, low aquatic productivity, and a degraded, channelized river are the norm below the dams.

Beyond their impact to the river ecology and anadromous fisheries, the dams have altered the river's estuary and nearshore marine environment, contributing to the erosion and steepening of beaches to the east, eliminating habitat for wildlife — several of them are now species of special concern (i.e. proposed or on federal or state lists of threatened and endangered species), and fundamentally changing the characteristics of the river morphology (see Impacts of No Action in this document for more information).

The reservoirs have covered cultural resources of great importance to the Lower Elwha Klallam Tribe, including the site where the Elwha Klallam believe their people were created. In addition to making cultural resources inaccessible, the dams affected the tribe by causing significant declines in harvestable fish, a resource promised in perpetuity by the federal government when it took control of tribal lands in the 1855 Treaty of Point No Point. The tribe considers the free-flowing river and its salmon to be cultural resources; these resources were spiritual and cultural centers over the thousands of years its people lived in the Elwha valley. Damming the Elwha and eliminating its abundant wild fish runs severely affected the tribe, and have contributed to a legacy of socioeconomic problems that persist today, including unemployment, poor health, and very low income. Also, although the chance of dam failure (from earthquake or other rare events) is low, the hazard potential for reservation (and other) residents downstream is high if such a failure occurs.

Need for Federal Action

The dams and reservoirs on the Elwha have been and continue to be the primary source of impact on the river's anadromous fish, aquatic ecology, and cultural resources. Since the bulk of the watershed is undeveloped and relatively pristine, removing the dams would restore fish, the river's ecosystem processes, and cultural resources to the Elwha Klallam people, and promote the federal trust responsibility to the tribe. No other river in the Pacific Northwest region has the unique, pristine habitat of the upper reaches of the Elwha River basin. Based on evidence summarized above about ecological and cultural effects of the Elwha and Glines Canyon dams, and the uniqueness of this system in a region wide context, the secretary of the interior has determined that the dams will be removed and the Elwha River ecosystem and native anadromous fisheries fully restored. The proposal at this time is to remove both dams in a safe, environmentally sound, and cost-effective manner.

Proposed Action – River Erosion Alternative

The proposed action is to restore the Elwha River ecosystem and native anadromous fisheries by removing both dams over a two-year period and implementing fish restoration and revegetation plans. Lake Mills would initially be drawn down with Glines Canyon Dam in place to provide flood control until a diversion channel to drain Lake Aldwell is finished; chances of delaying the construction of the diversion channel at the Elwha Dam would be reduced during high flow periods. Cofferdams would allow fill material upstream of Elwha Dam to be removed while dry and prevent a foundation failure similar to the one that occurred while Lake Aldwell was being filled in 1912. Elwha Dam would then be removed by controlled blasting, and Glines Canyon Dam by a combination of controlled blasting and diamond-wire saw cutting of concrete blocks. Sediment would be managed by river erosion. Details of this alternative, the proposed action, as well as the second action alternative which relies on dredging and slurrying fines for sediment control are described in the Alternatives chapter.

Relationship to Other Planning Documents

This environmental impact statement is referred to throughout as the *Implementation EIS*. Interior's previous programmatic EIS (June 1995) examined four action alternatives, as well as the No Action alternative. No Action was defined as leaving the projects in place, without fish passage. The action alternatives explored single dam removal scenarios, installing state-of-the-art fish passage at both dams, and the proposed action of removing both dams.

The programmatic EIS was based on information in two previous documents, as well as information developed since those documents were published. These documents are the *Elwha Report* to Congress, prepared by the US Departments of Interior and Commerce and the Lower Elwha Klallam Tribe, submitted to Congress in 1994; and a draft environmental impact statement prepared by the Federal Energy Regulatory Commission in review of licensing the two hydropower projects. The commission's environmental impact statement was updated and retitled *Draft Staff Report* in March 1993, and was adopted in large part in preparing interior's programmatic EIS. The *Elwha Report* was prepared in response to congressional direction in Public Law 102-495, the Elwha River Ecosystem and Fisheries Restoration Act, to study options and select a plan to fully restore the river ecosystem and its native anadromous fisheries.

The programmatic EIS gave the secretary of the interior several options for partial restoration, the No Action option, and the option of full restoration through dam removal. It analyzed the impacts of each policy decision, but noted that specifics of dam removal, sediment management, mitigation, land disposition and use, revegetation, and fisheries recovery would be further analyzed in a second environmental impact statement which would be geared to implement the approach chosen by the secretary.

This document is that second, *Implementation EIS*. It is procedurally connected (tiered) to the programmatic EIS titled *Elwha River Ecosystem Restoration*.

No other river in the Pacific Northwest region has the unique, pristine habitat of the upper reaches of the Elwha River basin.

Issues and Concerns

Issues and concerns are potential environmental problems that may result from the federal action, if it is taken. Issues were initially identified by the public, and by specialists in the National Park Service, US Bureau of Reclamation, US Fish and Wildlife Service, US Army Corps of Engineers, and from the Lower Elwha Klallam Tribe. A team of scientists and engineers from the agencies and the tribe, referred to as the EIS team in this document, collected and analyzed data on the potential for impacts on an extensive list of environmental resources. This list was supplemented with public input from two scoping sessions held in the fall of 1994, and with written comments collected from agencies and the general public during the 60-day review period for the programmatic EIS.

Most environmental problems from dam removal would be short-term, lasting from six months to three years. Some will be longer term or permanent. A summary of impacts is found at the end of the Alternatives chapter. A summary of issues and specific impact topics analyzed in this document is presented in table 3.

Table 3. *Substantive Issues and Concerns Analyzed in this EIS*

RESOURCE OF CONCERN	SUBSTANTIVE ISSUES	IMPACT TOPICS REQUIRING DETAILED ANALYSIS
Sediment	About 17.7 million cubic yards of clay, silt, sand, gravel, and cobbles have accumulated behind the dams, and much (less than half) of it would be released as a result of dam removal There would be the potential for increases in flooding from riverbed aggradation after dams are removed	Impacts to reservoir area through time Impacts to river morphology in downstream channel, delta area and beaches Impact on and measures to protect downstream land uses and structures including homes, cultural resources, wells, and existing levees
Surface Water	Releasing stored sediment would result in increases in turbidity, manganese and/or iron into surface water during dam removal, and increased spikes in turbidity after the dams are removed	Impact of river water quality Impact on and measures to protect Port Angeles industrial users (Daishowa and Rayonier mills) and state rearing facility Impact on and measures to protect Tribal fish hatchery
Groundwater	During dam removal fine sediment may infiltrate aquifers, increase turbidity and decrease yield Increased dissolved manganese and/or iron may change water quality Increased flood stage may change well water quality and quantity Change in groundwater levels may change downstream septic systems Increases in bedload may change well yields, either through wider meanders away from collection systems, or by burying existing riverbed collection systems	Impacts to and measures to protect from increased turbidity: Port Angeles water supply and Dry Creek Water Association wells; Lower Elwha Klallam Tribal Fish Hatchery; other users Impacts to and measures to protect from increases in manganese and iron: Port Angeles, Dry Creek Water Association and Elwha Place Homeowners' Association Impacts to and measures to protect from changes of water table levels to Lower Elwha valley users Impacts to and measures to protect from increased flood potential: Elwha Place Homeowners' Association and wells in the floodplain

RESOURCE OF CONCERN	SUBSTANTIVE ISSUES	IMPACT TOPICS REQUIRING DETAILED ANALYSIS
Native Anadromous and Resident Fisheries	The restoration potential, and time to restore each stock after dam removal varies, and depends on stock availability, fishing pressure and habitat Fish habitat would change in the long term following dam removal Reintroduction of salmon would increase competition with resident trout Release of fine sediment during dam removal would kill fish exposed to it, coat and kill eggs and potentially cause in-migrating adults to avoid entering the river	Assessment of stock availability, habitat and fishing pressure on chinook (summer/fall and spring), coho, steelhead (summer and winter), pink, chum, sockeye, steelhead, sea-run cutthroat trout, and native char Long-term impacts from dam removal to habitat downstream of dams; restoration of inundated areas to riverine habitat; impacts to resident species Short-term impacts to and protection from turbidity for above stocks
Vegetation	Areas occupied by the reservoirs or dams would revegetate following removal Some small changes in existing vegetation would occur during or following removal	General acreages of vegetation types which would return following dam removal; specific impacts to riparian and upland communities and wetlands; revegetation plans Wetlands associated with reservoir shorelines; upland vegetation removed to facilitate dam removal, waste disposal
Wildlife	Revegetated areas would provide wildlife habitat; restored salmon would be a source of prey and nutrients for wildlife Loss of reservoir habitat would adversely affect trumpeter swans and ducks which use it	Impacts on terrestrial ecosystem; wildlife overall; elk and other large mammals; trumpeter swans, lesser scaup and diving ducks; fish eating mammals, raptors, and other birds; amphibians

RESOURCE OF CONCERN	SUBSTANTIVE ISSUES	IMPACT TOPICS REQUIRING DETAILED ANALYSIS
Species of Special Concern	Site-specific effects from dam removal (noise, dust, human activity) Change in existing habitat and long-term restoration of riverine, riparian, wetland and upland habitat	Impact on four federally listed threatened species, and one endangered species (listed respectively): -bald eagle -northern spotted owl -marbled murrelet -Stellar sea lion -peregrine falcon (endangered) Impact on six species that are candidates for federal listing, and five species that are candidates for state listing (listed respectively): -Pacific fisher -Harlequin duck -Northern goshawk -Cascades frog -Northern red-legged frog -Bull trout -Pileated woodpecker -Common loon -Van Dyke's salamander -Vaux's swift -Golden eagle Impact on six sensitive plant species
Living Marine Resources	High turbidities at the river mouth during removal would kill or harm some marine life in the short-term Replacement of rocky nearshore marine substrate with a mixture of substrates would change the species make-up over time Restored sediment transport would restore the size and complexity of the Elwha delta and estuary over the long term	Impact on nearshore marine community (including direct and indirect effects on macroalgae (kelp) and indirect effects on rockfish, greenling, red rock crab, chitons, clam species and cragon shrimp) Long-term impacts to species dependent on sandy or mixed substrate (Dungeness crab, littleneck, butter, horse and geoduck clams, sand lance, surf smelt, eelgrass, and species of green algae) Impacts to delta and estuary
Air Quality	Construction dust would increase over background during dam removal	Impacts to air quality in and around the damsites during their removal from increases in PM10 and TSP Impacts to local residents from dust and construction activity

RESOURCE OF CONCERN	SUBSTANTIVE ISSUES	IMPACT TOPICS REQUIRING DETAILED ANALYSIS
Ambient Noise Level	Ambient noise levels would increase during construction, and may be heard by residents or wildlife	Impacts on local residents and park visitors from increased continuous noise levels (dBA) as dams are removed Impacts to above from acute instances of loud noise (such as blasting) Impacts of and protection from noise on species of special concern (marbled murrelets and Northern spotted owls)
Cultural Resources	Removal of the hydroelectric projects means the loss of two historic resources Cultural resources in or near the floodplain may experience increased flooding or erosion from aggradation and increased surface water elevation during and following dam removal Construction activities, road grading, trenching to bury the slurry pipeline and offsite disposal of dam rubble could damage known or unknown cultural resources Draining the reservoirs and removing the dams may uncover cultural resources now inaccessible to members of the Lower Elwha Klallam Tribe	Construction-related impacts and mitigation of these impacts to the hydroelectric projects; to cultural resources now inundated or buried by the projects, including the tribe's cleansing site, prophecy hole, and creation site; to cultural resources potentially affected by waste disposal or road grading Impacts from increased flooding or erosion and mitigation of these impacts to resources in the floodplain (Elwha Ranger Station Historic District, Elwha River bridge, CCC community kitchens in Altaire and Elwha campgrounds; archeological sites, cultural landscapes, or culturally sensitive areas)
Socioeconomics	Changes in the existing local and regional socioeconomic characteristics, such as employment sectors, may result from dam and reservoir removal Daishowa Mill would need a replacement source of power and costs for that power may change as a result Restoring fisheries in the Elwha River would increase commercial income from salmon fishing for tribal and non-tribal fishers Supplying workers for a 10-year period of preparation, construction and restoration may change the demand for local housing and public services	Impacts to county economic tax base; increases in jobs, payroll and business activity during the construction period; long-term impacts to Clallam County businesses from recreation and tourism dollars Impacts to real cost of providing replacement power to Daishowa Mill; impacts to municipal power users Impacts to public infrasturcture/housing Impacts on annual net business benefits from dam removal and fishery restoration Impacts on tribal social and economic conditions Impacts to social values Impacts on nonmarket benefits from dam removal and fishery restoration

RESOURCE OF CONCERN	SUBSTANTIVE ISSUES	IMPACT TOPICS REQUIRING DETAILED ANALYSIS
Public Health and Safety	The dams may present a safety risk to downstream residents due to earthquakes If removed improperly, the dams may present a safety risk to workers, visitors, residents and others using the river corridor. A failure of the fill under Elwha Dam due to hydrostatic pressure of the reservoir is of particular concern Some hazardous wastes exist at the damsites, and may pose risk to health and safety of workers and the general public	Risk and impacts posed to downstream residents by dam failure during shallow, deep and megathrust earthquakes Risk of failure during probable maximum flood or maximum credible earthquake given safety and strengthening measures already taken Impacts on and measures to protect workers, visitors, and others using the river corridor from sudden increases in water levels as dams are removed Impacts on and measures to protect workers and the general public from exposure to hazardous wastes found in dam-related structures as they are removed
Transportation	Removing dam rubble, and transporting personnel, equipment and supplies in and out of the damsites would increase traffic volume and congestion at intersections	Impacts on local road conditions from heavy equipment during dam removal Impacts on level of service at key intersections and road corridors from increased traffic volumes during dam removal
Indian Trust Resources	The dams adversely affect the federal government's responsibility to protect tribal resources	Impacts of dam removal and fisheries restoration and restoration of shellfish as a tribal resource by estuary expansion and return of sandy nearshore substrate Impacts of restoring wildlife habitat for game Elimination of dams as a potential safety hazard

RESOURCE OF CONCERN	SUBSTANTIVE ISSUES	IMPACT TOPICS REQUIRING DETAILED ANALYSIS
Recreation	In the long term, water-related uses of the Elwha River valley would change from reservoir and river, to those associated with the river Fishing would be restricted in short term, but would increase in the long term as salmon and steelhead return Recreationists using the Elwha Subdistrict of the park would need to find alternative locations during dam construction, because the sites would be closed to visitors.	Impacts on recreation facilities, including the reservoirs Impacts on recreational fishing, including flat water, residential trout and sport fishing for salmon and steelhead Impacts on other recreational activities, including white-water boating; recreational fishing; camping; hiking; recreational facilities and wildlife observation
Land Use	The hydroelectric facilities conflict with numerous agency plans, and do not conform with neighboring land use Olympic National Park would acquire and manage lands now occupied by Lake Mills and Glines Canyon Dam facilities Future land managers of the Lake Aldwell lands may use or develop the lands. This use or development would affect vegetation, wildlife, air quality, cultural resources, recreation, traffic flow, aesthetics, water quality and/or fisheries Rubble and other waste from dam removal would restrict future use of land	Impacts to Olympic National Park from management of acquired Glines Canyon lands Impacts from future management of Lake Aldwell lands on land ownership, use and resources if Olympic National Park, US Fish and Wildlife Service, Washington State or the Lower Elwha Klallam Tribe acquires Impacts from waste disposal
Aesthetic Resources	The appearance of uncovered reservoir land in the short-term is of concern Long-term management of the restored landscape is important to visitors, recreationists, land managers, etc.	Impacts on project area landscape from removal of dams and related structures and restoration of the river corridor Impacts on management of aesthetic resources after dams and reservoirs are removed

Issues Dismissed From Further Analysis

Sediment Management

Scoping comments were received suggesting further investigation of land disposal of the fine sediment instead of slurrying and of selling or using dredged fines as a soil amendment. Land disposal of sediment was considered, but eliminated because of problems in trying to contain fine sediment. The land area required would be enormous, sediments would be saturated, and the cost of slurrying or trucking the fines would be prohibitive. Additional details on the reasons for eliminating this as an alternative are in the Alternatives chapter, Alternatives Considered but Rejected section.

Scoping comments also were received on stabilization of sediment by mechanical means (see Alternatives considered but rejected section).

Water Quantity and Quality

Water quality parameters affected by the action alternatives are analyzed in the Impacts section of this document; the Affected Environment section presents water quality statistics for the Elwha River. The water quality parameters dropped from further detailed analysis (as largely irrelevant in this document) are hardness, alkalinity, dissolved solids, nitrate nitrogen, ammonia nitrogen, total phosphorous, ortho phosphorous, and radio nuclides. Commentors asked that alternative sources of water (such as Morse Creek) be investigated. Responses to these concerns are found in the programmatic EIS.

Many mitigation measures were examined. Some were carried forward for additional analyses, and these appear in the Impacts to Surface Water and/or Groundwater sections of this document. Some were dropped as unnecessary as further data were collected, and some eliminated for cost reasons (BOR 1995a, 1995b).

Native Anadromous and Resident Fisheries

Scoping comments on fish passage measures in lieu of removal of the dams were analyzed in the programmatic EIS. The preferred (and ultimately selected) alternative in that document was the full restoration of the native anadromous fisheries and ecosystem through the removal of both dams; therefore, further analysis of fish passage measures in lieu of dam removal is outside the scope of this Implementation EIS.

Living Marine Resources

Scoping comments were received suggesting that dam rubble be used to build an artificial reef in the Strait of Juan de Fuca or that rubble be transported to other areas to build habitat for marine resources. At this time, it appears that the costs of implementing this option outweighed the potential benefits to living marine resources. It is not further analyzed in this EIS, although the dam removal contractor may wish to explore possible beneficial re-use of this dam rubble.

Air Quality and Climate

The two air quality parameters most relevant to the proposed action and alternatives are total fine particulates (PM_{10}) and total suspended particles; these are fully analyzed in this document. All other air quality parameters were analyzed for potential impacts and deemed inconsequential, with no measurable changes to local or regional climatic conditions; therefore, this issue was dismissed from detailed analysis.

Socioeconomics

Housing and public infrastructure were assessed for the ability to accommodate the short-term workforce population and determined to be adequate; therefore, this issue was dropped from further detailed analysis.

Power Generation

Comments were received during the scoping period about co-generation of power, reducing the mill's energy requirements, and using alternative sources of power. These issues were addressed in the final programmatic EIS (DOI et al. 1995), Response to Comments, and therefore are not discussed further in this Implementation EIS.

Elwha River, no date. (Clallam County Historical Society)

Land Use

The state of Washington and the US Fish and Wildlife Service explored the potential of managing Lake Aldwell project lands after dam removal, but have no desire to pursue ownership. The lands qualify for inclusion in Olympic National Park and as trust lands for the Lower Elwha Klallam Tribe. Therefore, impacts from potential ownership of these project lands from entities other than the National Park Service or Tribe are considered outside the scope of this document.

Planning Goals and Objectives

The Elwha River Ecosystem and Fisheries Restoration Act identified full restoration of the Elwha River native anadromous fisheries and ecosystem as its primary goals. In this *Implementation EIS*, full restoration of the native anadromous fisheries and ecosystem remain primary goals. In addition, the EIS team formulated additional broad goals and more specific objectives based on scientific, regulatory, policy and legal requirements. All alternatives had to meet these goals and objectives to be considered reasonable. The goals are presented below, and a list of specific objectives is available in the National Park Service file for this project.

Major Goals in Taking Action

1. Fully restore native anadromous fisheries
2. Fully restore the Elwha River ecosystem
3. Maintain and protect existing municipal and industrial water quality against adverse impacts of dam removal
4. Within Olympic National Park conserve, maintain and restore those ecological relationships, components and processes that would prevail if not for the advent of modern civilization
5. Outside park boundaries (i.e. Lake Aldwell acquired lands), restore the pre-dam river corridor landscape for ecosystem restoration and for ceremonial and other tribal purposes
6. Maintain public access to the river (on park and non-park lands) as consistent with fish and habitat restoration programs
7. Protect or mitigate impacts to important cultural resources
8. Restore access to viable Elwha River fisheries secured by predecessors to the Lower Elwha Klallam Tribe by the Treaty of Point No Point
9. Maintain present level of flood protection or mitigate to the extent possible for those affected by Elwha River flooding.

Alternatives

Previous page: Fishing the Elwha in the 1920s. (Asahel Curtis photo, Washington State Historical Society)

Excavating the Glines Canyon Dam tunnel. (Daishowa/James River Company photo)

Alternatives

Range of Alternatives

This chapter describes the range of reasonable alternatives selected for analysis in this environmental impact statement. The process began with public scoping of issues and alternatives in November 1994. Alternatives identified during scoping included those initially examined in the 1994 *Elwha Report*. All alternatives were considered by the EIS team; those considered reasonable were selected for further analysis. These preliminary alternatives were subsequently reduced to the three alternatives presented in this chapter. Since most significant issues focus on releasing sediment accumulated in the reservoirs, the team's analysis centered on different methods of sediment management. The two action alternatives are river erosion of the sediment (Proposed Action – River Erosion alternative), and dredging, slurrying, and piping of the sediments to the Strait of Juan de Fuca (Dredge and Slurry alternative). Analysis of a No Action alternative is required, and establishes a baseline of comparison for the two action alternatives. A discussion of the alternatives considered but rejected, including the reasons why, is presented in the final section, "Alternatives Considered But Rejected."

Existing Project Features

Existing features of both dams are described in table 4 and shown in figures 4 and 5.

No Action Alternative

The hydroelectric projects would remain in place as they are now. No action would be taken to license the dams or install fish passage. This alternative is required to set a baseline for comparison of impacts before and after dam removal.

Project features as described in the first section of this chapter would remain as is. Impacts of no action, i.e., of leaving the dams in place, are summarized at the end of this chapter in chart form, and are described in more detail in the Impacts chapter.

Dam Operations

Under the No Action alternative, both dams are assumed to continue operation without significant changes. Both projects are operated as run-of-river, typically with only minor fluctuations in reservoirs. Natural in-stream flows are not changed by the

Table 4. *Summary of Features for Existing Projects*

FEATURE	ELWHA PROJECT	GLINES CANYON PROJECT
Impoundment		
Name	Lake Aldwell	Lake Mills
River Mile	4.9	13.4
Length of Reservoir (miles)	2.8	2.5
Crest of Dam (ft msl)	199.5	590.33
Water Surface Area (acres)	267	415
Gross Storage (acre-feet)	8,100	40,000
Concrete Dam Section		
Year of Construction	1910-14	1926-27
Type	concrete gravity	concrete arch
Overall Length (ft)	450	270
Structural Height (ft)	108	210
Crest size (ft x ft)	8 x 112	4 x 150
Base width (ft)	100	46
Volume (yd3)	12,800	16,000
Sluiceways	4 (plugged)	1 (abandoned)
Water Conveyance Structures		
Intake Structure	1	1
Penstocks	4	1
Surge Tanks	1	1
Gated Spillways	2 (1 north, 1 south)	1
Powerplant and Transmission Facilities		
Turbine-generators	5	2
Overhead Transmission lines	line 1: 6 mi; line 2: 8 mi	line 3: 7 mi
Powerhouse	1	1
Transformer location	powerhouse	switch yard
Buildings and Miscellaneous Structures		
Maintenance shops/garages	1	2
Residences	0	2
Other outbuildings	2	2
Thrust Block	0	1
Embankment Dikes	0	2
Gate house	0	1

projects and only very minor changes in flood magnitudes occur because of them. Details on current project operations may be found in the FERC *Draft Staff Report* (1993, page 2-1), the *Elwha Report* (DOI et al. 1994), and the *Final Environmental Impact Statement* for Elwha River Ecosystem Restoration (DOI et al. 1995).

Sediment Management

Bedload sediment (sand, gravel, and cobbles) and much of the suspended load would continue to accumulate in the reservoirs and existing water quality conditions would also continue. Operation of the dams would not be impacted by accumulating reservoir sediment for approximately another 200 years.

Flood Control

Approximately 60 homes lie within the 100-year floodplain now, and are currently susceptible to flooding even though partially protected by levees, dikes or other measures. The Lower Elwha Federal Flood Control Levee protects most residents of the Lower Elwha Klallam Reservation and adjacent lands from up to the 200-year flood. A private levee on the west side of the river near its mouth provides protection for some residents in this area from 25- to 50-year floods (see figure 9, Flooding Affected Environment).

> ***...elevated water temperatures aggravate fish diseases, and diminished nutrient levels reduce aquatic insect production.***

Fisheries Recovery

Given the assumptions of this alternative, no fish recovery efforts would be conducted, although hatchery operations for chinook, coho and steelhead would continue.

Revegetation

Since the reservoirs would not be drained or structures removed, no revegetation would be needed.

Water Quality

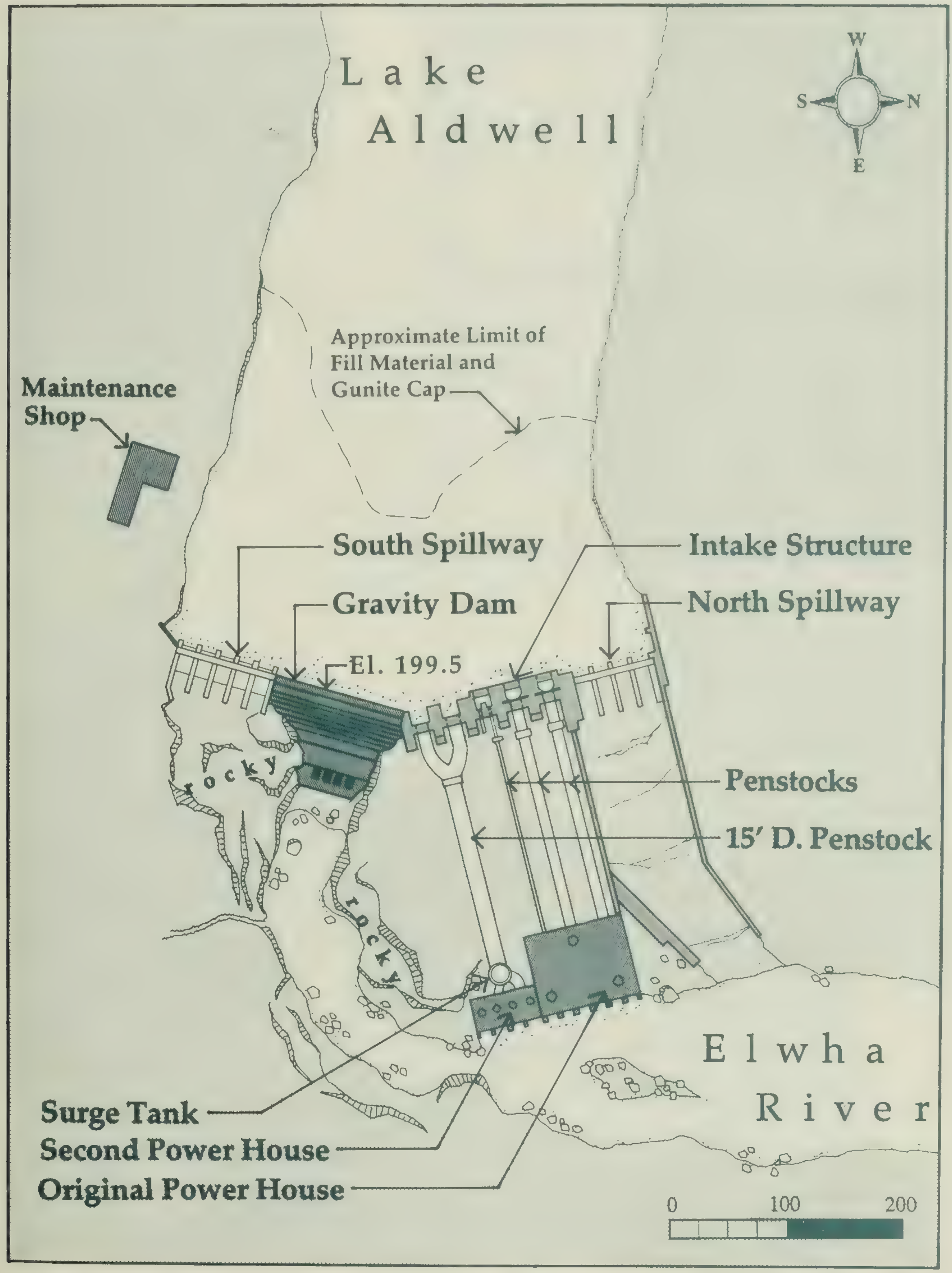
Water quality in the Elwha River is excellent for domestic and industrial water use. River water used by industrial, domestic, and hatcheries downstream has a much lower sediment content during heavy rainstorms (or other high sediment-loading events such as upstream landslides) than the natural undammed river would have. However, elevated water temperatures aggravate fish diseases, and diminished nutrient levels reduce aquatic insect production.

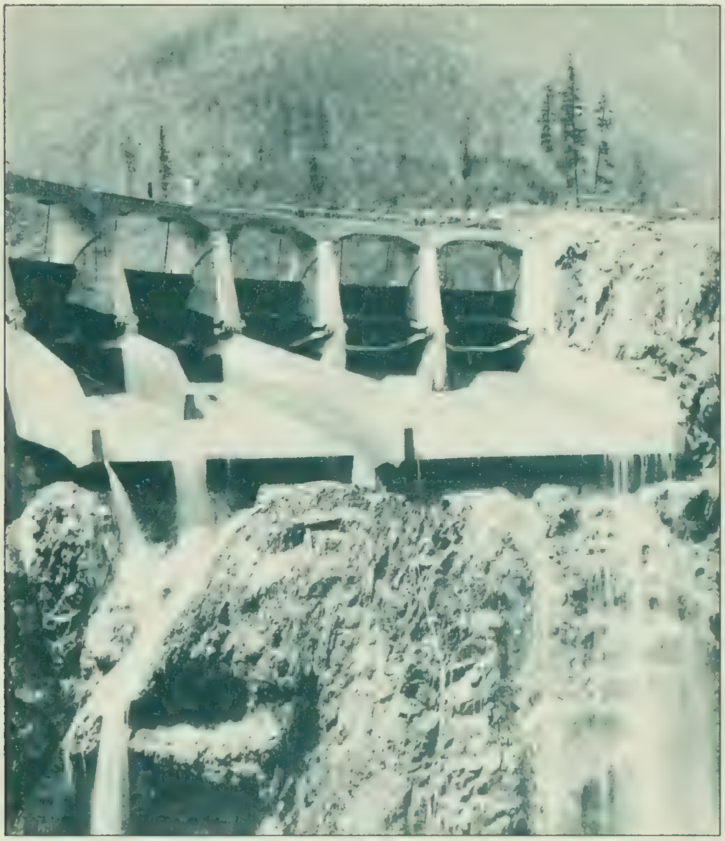
Water treatment for water users varies. Treatment for the city domestic water consists of only chlorination. The water is naturally filtered by riverbed sands and gravels as it is pumped from the Ranney collector. The mills use a settling channel upstream of the supply pipe, and treat inflow from the pipe with flocculation, settling, and filtering.

Elwha Dam and Powerhouse, 1994. (Janis Burger photo)

Elwha Dam, 1995. (Maggi Johnson photo)

Figure 4. *Elwha Dam Features*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20065





Glines Canyon Dam spillway, no date. (Clallam County Historical Society photo)

Glines Canyon Dam and Powerhouse, 1924. (Daishowa/ James River Company photo)

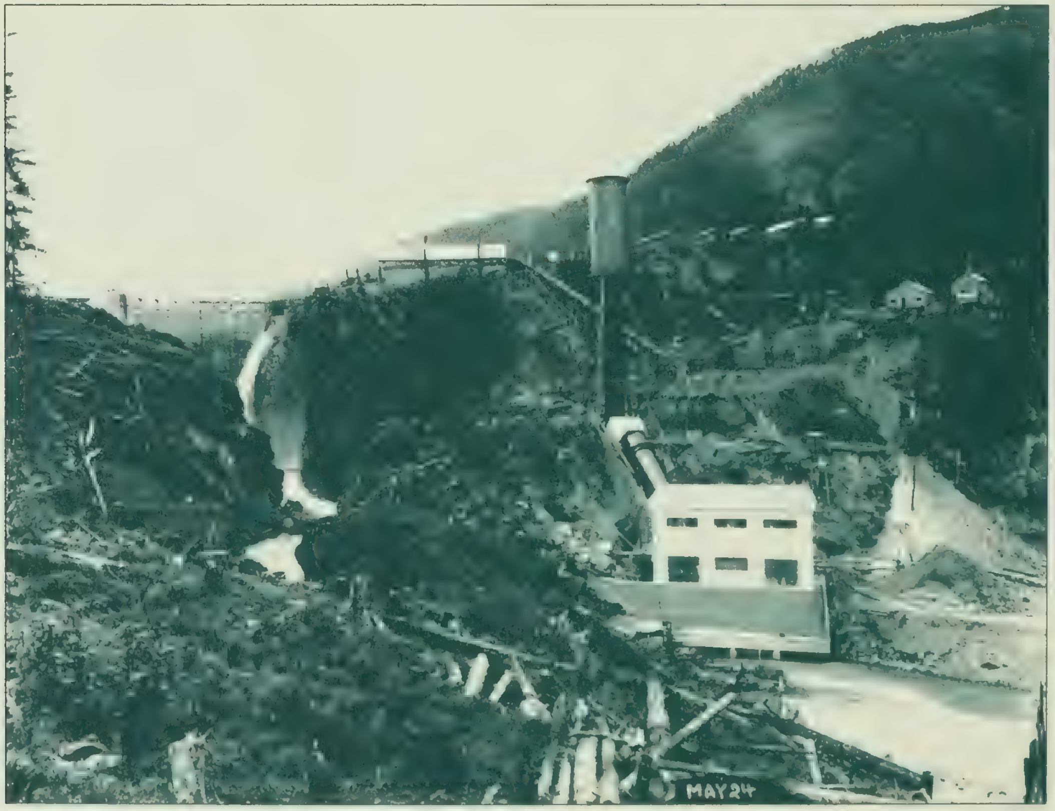
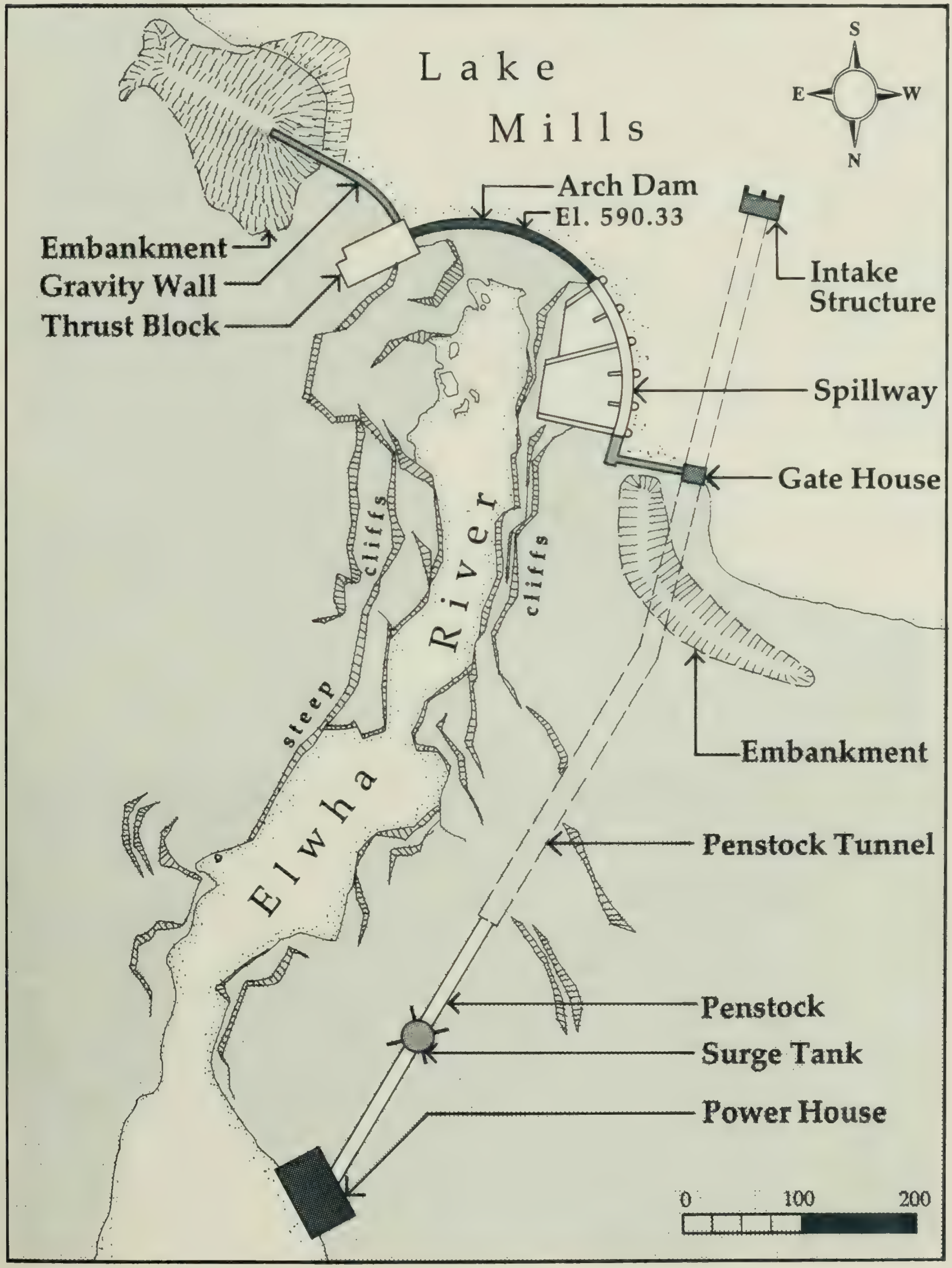


Figure 5. *Glines Canyon Dam*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20066B



Disposition of Lands

All project lands would remain in existing ownerships. James River Corporation owns all of the 1018-acre parcel surrounding Lake Aldwell and the Elwha Dam. James River also owns 160 acres surrounding the Glines Canyon Dam; the remainder of the land around Lake Mills is public land managed by the National Park Service.

Interpretation

There would be no changes in interpretation. Neither the National Park Service nor James River Corporation has a specific interpretive effort at the sites.

Cultural Resources

The mitigation of impacts to cultural resources would not occur. Elwha Klallam sites would remain covered by the reservoirs and inaccessible. The historic dams would not be removed. There would be no increased threat of loss for archeological sites or the Elwha Ranger station historic district.

Costs

Costs to operate both dams average between $6 and $10 per megawatt hour or $1 to $1.5 million per year (FERC 1993 p. 2-37). For this cost, the mill receives approximately 38% of its annual energy requirements. Required repairs at the two dams would cost an estimated $8.7 million in the near future (FERC 1993 p. 2-19).

There are no sediment management costs directly related to the projects, although the US Army Corps of Engineers spends approximately $100,000 per year on maintenance of Ediz Hook — to which the Elwha projects reduce sediment supply by 35%. Operation of the state rearing channel costs about $235,000 per year, while that of the tribal hatchery costs about $245,000 per year.

Permitting

It is unknown how the Federal Energy Regulatory Commission licensing process would be resolved in the future. Prior to Congress passing the Elwha Restoration Act, the commission had nearly completed a final environmental impact statement. The proposal to license the dams in their environmental impact statement included major and very costly modifications to the projects, including upstream fish passage. The jurisdiction of the commission over the licensing of Glines Canyon Dam was the subject of complex, active litigation before the federal appellate court. This litigation was suspended only because of passage of the Elwha Act. The resumption of the licensing effort and litigation might be the eventual outcome under the No Action alternative.

Proposed Action – River Erosion Alternative

Summary of Actions

Features of the River Erosion alternative include:

- removing features of the dams necessary to restore fish passage and ensure public safety
- erosion of reservoir sediments by natural river processes
- restoration of historic anadromous fish runs
- revegetation of the reservoir areas
- monitoring of sediment transport and river channel topography, water quality, and aquatic ecology
- short and long-term protection of municipal and industrial water supplies from adverse impacts of dam removal
- mitigation of flood impacts to Lower Elwha Klallam Reservation residents caused by long-term river aggradation
- reservoir drawdown in controlled increments with periods of constant lake elevation in between
- short-term protection of native fish stock

These elements of the proposed action are discussed in this section in more detail and also analyzed in the Impacts section. Those mitigation measures detailed above (as well as others summarized in table 5) are considered integral to the project, and are required either by law or regulation or to achieve goals or directives in the Elwha River Ecosystem and Fisheries Restoration Act (PL 102-495). Other mitigation measures not specifically required, but desirable to minimize impacts to important resources, are recommended (see table 5), and would be added depending on project funding.

Both Elwha and Glines Canyon dams would be removed in controlled increments; there are no plans to suddenly breach either dam. Since there is no low-level release capability from either dam (to drain reservoirs or remove sediment), removal plans include river diversion options.

The plan to remove Glines Canyon Dam focuses on notching down the dam. Lake Mills would be drained through these notches cut into the dam, allowing the part of the dam above the notches to be removed while dry.

The removal of Elwha Dam is more complicated than the removal of Glines Canyon Dam. The alluvium under Elwha Dam eroded upon initial filling of Lake Aldwell which caused a large void under the gravity section. The breach was repaired by filling the area upstream and downstream of the dam with rock debris blasted from the canyon walls. Other fill material, including sand and gravel, a fir mattress, and a gunite cap (sprayed concrete), was subsequently placed to control seepage. However, the void still exists under the gravity section. This fill material is now considered part of the dam, and its removal under full lake conditions could potentially cause another failure

Table 5. *Summary of Mitigation Measures for River Erosion and Dredge and Slurry Alternatives*

TOPIC	PART OF ACTION ALTERNATIVES	RECOMMENDED MITIGATION
Fluvial Processes and Sediment Transport		
Long-term sediment monitoring (cross-sections, air photos, stream gauging)	X	
Flooding		
Raise and strengthen federal levee to maintain existing 200 year flood protection	X	
Adjust rate of Glines Canyon Dam removal to control release rate of coarse sediment		X
Raise individual houses		X
Raise and reinforce non-federal west side levee		X
Water Quality		
Dredge and slurry some of silt and clay sized materials from reservoir areas*	X	
Construct infiltration gallery / diversion modifications, open channel, pre-treatment for industrial users	X	
Construct new Ranney collector, temporary iron treatment / filtration for municipal water use	X	
Replace hatchery infiltration gallery, drill supplemental wells for Lower Elwha Klallam Reservation	X	
Construct mounded septic system with lift stations for Lower Elwha Klallam Reservation		X
Connect to Ranney system or build new treatment system and wells for Dry Creek Water Association	X	
Modify wellheads, flood-proof pump house, install temporary in-line water treatment system for Elwha Place Homeowners' Association		X
Raise and modify wellheads, install temporary in-line filters, construct temporary storage tanks, provide bottled water, deepen existing wells, drill new wells, provide contingency fund for private well users not yet identified		X
Close WDFW fish rearing channel during dam removal	X	
Provide long-term wellhead protection at WDFW fish rearing channel		X

TOPIC	PART OF ACTION ALTERNATIVES	RECOMMENDED MITIGATION
Fisheries		
Gradual/intermittent release of water and sediment from reservoir		X
Dredge and slurry some of silt and clay sized materials from reservoir areas*	X	
Prior to dam removal, outplant eggs or fry in upper river	X	
Shut down dam removal activities to ensure minimum riverflows	X	
Stop construction during high flows to protect fish (November and May to June)	X	
Develop broodstocks, outplant juveniles, and evaluate adult return during and after dam removal	X	
Expand Lower Elwha Klallam Tribal Fish Hatchery; dredge outlet, create new bypass	X	
Vegetation		
Collect native plant materials from the Elwha Valley, seed both reservoirs with native grasses and forbs, plant trees of different ages and eradicate non-native vegetation.	X	
Literature search, controlled planting, on-site cultivation, and biotechnical slope stabilization		X
Wildlife		
Trumpeter Swan mitigation		X
Species of Special Concern		
Noise reduction measures or changes in sequencing and timing of construction activities	X	
Air Quality and Noise		
Periodic spraying of roads with water	X	
Cultural Resources		
HABS/HAER documentation of dams	X	
Leave parts of Glines Canyon Dam in-place (thrust block, powerhouse, spillway, penstock, and gatehouse)	X	
Documentation of affected resource(s), monitor, survey, stabilize riverbank, data recovery, and avoidance	X	

TOPIC	PART OF ACTION ALTERNATIVES	RECOMMENDED MITIGATION
Public Health and Safety		
Cofferdams, progressive reservoir lowering and other measures to prevent foundation washout under Elwha Dam	X	
Stop construction during high flows to protect dam workers (November and May to June)	X	
Remove transformers, asbestos, and chemicals from damsites (hazardous materials)	X	
Traffic		
Flaggers at congested intersections if needed	X	
Recreation		
Close watershed access	X	
Provide shuttle service for park visitors to Elwha subdistrict during dam removal		X
Restrict fishing during restoration	X	
Provide interpretive facilities		X
Educate users on nearby similar opportunities		X
Land Use		
Leave bottom lands and lands along river corridor undeveloped	X	

* Dredge and Slurry alternative only

(water flowing under the dam). A sequence of cofferdams and diversion channels is necessary for the safe removal of Elwha Dam (see specific dam removal description below).

The proposed action would allow the sediments presently trapped in Lake Mills and Lake Aldwell to be eroded from the reservoirs (to the extent possible) and transported downstream to the Strait of Juan de Fuca by natural processes.

River erosion is a minimum cost option for sediment management (Randle and Lyons 1995). Except for controlling lake elevations during reservoir drawdown and the rate at which each dam is removed, the river initially would be allowed to erode reservoir sediment without mechanical intervention (such as hydraulic dredging). However, regrading of the remaining sediment to achieve a stable slope configuration may be necessary.

The rate of sediment release from the dam would depend on the rate of dam removal, lake inflow, and sediment particle size. Slow rates of sediment release would tend to reduce the magnitude of short-term effects but would increase the duration of those effects. High rates of sediment release would tend to reduce the duration of short-term impacts but increase their magnitude. In the case of fish, even slow rates of fine-grained sediment release may prove to be lethal or cause fish to avoid entering the river. Therefore, high-magnitude, short-duration impacts would be preferred over low-magnitude, long-duration impacts. Elwha and Glines Canyon dams would be removed over a two-year period to minimize the duration of high sediment concentrations in the river.

River erosion is a minimum cost option for sediment management.

For both lakes, water surface elevations would be controlled during reservoir drawdown. Each lake would be drawn down in stages in order to redistribute reservoir delta sediments within the reservoir. After each increment of drawdown, the lake levels would generally be held constant for about two weeks. These drawdown stages would continue until the lakes are completely drained.

Delta sediments of both lakes would erode and redeposit, forming a sequence of new deltas downstream (corresponding to the two-week drawdown increments), and temporarily covering the existing lake bed sediments. Deposition of delta sediment farther downstream within the reservoir is expected to be uniform across the reservoir and eventually reach the dam. The slope of the redeposited delta material would largely depend on the sediment particle size and river flow. No significant quantities of coarse-grained sediment would be released beyond the damsites until the dams are removed down to an elevation near the top of the redeposited deltas. Dam removal below this elevation would result in the release of high sediment concentrations.

For both lakes, fine-grained sediments would erode much faster than coarse-grained sediments. Some boulders and cobbles present in the upstream portions of the delta may not erode at all. For a given peak river flow during the initial erosion process, an armor layer of cobbles and boulders may develop that would prevent the erosion of finer sediments underneath. The potential armor layer and the underlying sediments would be eroded later by higher river flows of sufficient duration. Since the volume of cobbles and boulders is relatively small, any armor layers would be left to natural processes unless they impede fish passage. If necessary, erosion of this armor layer would be initiated by blasting to allow fish to swim upstream.

River and estuary conditions (both physical and biological) and water intakes would be extensively monitored during the erosion of reservoir sediments. Monitoring information could be used to adjust the rate of dam removal and, therefore, the rate of sediment release. Sediment would be released as rapidly as possible to minimize the duration of impacts, but without exceeding the river's sediment transport capacity or the capacity to treat municipal and industrial water.

Dam Removal

Specific details for proposed removal plans (BOR 1995c) are different for each dam because of structural differences and site characteristics, although removal of both involves very similar construction activities. One primary difference in how the dams are removed would be the control of stream flow during the removal process.

The proposed schemes for removing the dams are based on assumptions that the same contractor would be responsible for removing both dams and that construction would begin in November. The major steps for removal of both dams following acquisition include: site access preparation and mobilization; river diversion; structure removal; waste removal and disposal; and site restoration. At the Elwha damsite, all structures would be removed from or buried at that site. Portions of the Glines Canyon Dam that do not impede fish passage, and that cultural resource specialists believe are historically important, would be left in place.

Cobbled shoreline of the lower Elwha River. (Curtis Miller photo)

Elwha Dam Removal

Elwha Dam removal would include pre-removal activities, dam removal, and final site restoration. The full activity sequence is developed in a project scheduling program (BOR 1995c; and see appendix 6). One of the primary objectives driving the sequence of activities would be to ensure that another failure below the gravity section does not occur as it did in 1912.

Pre-removal Activities. Decommissioning is the shutdown of the power plant with continued operation of the dam in a stable run-of-river condition prior to removal. Project decommissioning entails any work at the Elwha Dam power plant required in advance of the dam removal contract work, including de-energizing the electrical equipment, preparing selected equipment for long-term storage, removing hazardous materials, rerouting transmission lines, decommissioning the grounding grid, and removing smaller items of historical value. The turbine runners would be removed from Units 3 and 4 to permit no-load water releases through the 15-foot-diameter penstock. This work would likely be completed under one or more small contracts prior to dam removal. Hazardous waste collection and disposal is discussed in Impacts to Public Health and Safety. Improvements required to use Olympic Hot Springs Road to carry heavy equipment would also be done prior to dam removal.

Resource protection and implementing fisheries restoration would begin one to two years before dam removal. The Lower Elwha Klallam Tribal Fish Hatchery would be expanded and changes made to ensure clean water is available during dam removal to protect broodstock and begin outplanting. Measures to protect against impacts from water quality degradation or flooding would also be installed long before dam removal begins. Documentation to ensure that historic qualities of the hydroelectric projects are fully inventoried is already well under way.

Dam Removal Activities. The contractor would begin site mobilization in November of the year that construction is scheduled and continue through the winter months. Lake Aldwell would be drawn down by March 1 to approximately elevation 182, using the south spillway and the 15-foot-diameter penstock for reservoir releases. This would allow cofferdam construction and excavation of a diversion channel in the north spillway. The lake would again be drawn down to elevation 182 following the spring runoff (May-June).

When Elwha Dam was first completed, the water from the reservoir washed out alluvium on which the concrete gravity structure rested and caused catastrophic flooding downstream. Fill material — composed primarily of rock blasted off the upstream canyon walls, earthfill, "mattresses" of fir trees, and a concrete (gunite) cap — was placed upstream of the dam to block the river's ability to penetrate into the alluvial foundation. The technical challenge this fill imposes on the removal of Elwha Dam requires diverting the river from the gravity structure while the fill material is being removed.

A surface diversion channel would be excavated through the north spillway channel to lower the reservoir level to permit removal of the concrete gravity section from the original river channel. Glines Canyon Dam would be operated to reduce flood peaks during this period to facilitate the construction of the diversion channel.

The construction of the surface diversion channel would begin with building a temporary 10-foot-high cofferdam within the north spillway approach channel. This would keep the channel area dry enough to remove the gunite and construct a larger, sheet-pile cofferdam approximately 20 feet high between the left abutment and a concrete block near the intake structure. The sheet-pile cofferdam would provide construction access to a crane pad and flood protection for the work area. The crane would remove the north spillway gate structure and penstocks. A dragline would be used within the reservoir upstream of the sheet-pile cofferdam to excavate the diversion channel to elevation 135. The lower portion of the diversion channel in the bedrock would be excavated by controlled blasting.

Following excavation of the diversion channel upstream and downstream of the cofferdam, the cofferdam and remaining bedrock plug would be removed. The cofferdam would be removed first. The bedrock plug would then be removed under flow conditions in a controlled manner. Small sections of the bedrock plug would be removed by pre-drilling and controlled blasting to specified depths, resulting in instantaneous peak discharges that would not be expected to exceed an estimated 3000 cubic feet per second. The entire process may take up to three weeks to allow for conditions within the reservoir to stabilize between removal stages.

Streamflow diversion would continue through the newly excavated channel for one year, with reservoir levels for average conditions varying between elevations 138 and 144. During the low-flow period of the second year, excavation within the channel fill materials would progress below the water level within the diversion channel, resulting in the diversion of streamflow along its original course through the damsite. The river channel would be lowered in 5-foot increments along its full length until reaching the desired surface at approximate elevation 90. This work would be performed over a three-month period from August through October, including final channel cleanup.

All concrete structures above final grade would be removed from the Elwha Damsite. Concrete structures below final grade of the river channel and adjoining areas would be buried during landscape recontouring. Additional material buried on site would include an estimated 17,500 cubic yards of concrete and 10,400 cubic yards of compacted rockfill generated by the dam removal process. This material would be used to backfill the north spillway outlet channel and penstock area to restore natural contours. The rockfill also would be used as riprap for erosion protection. Wood-frame structures would be retained for use during the demolition contract, then removed. All mechanical and electrical items, timber, glass, fencing, and hazardous materials would be removed from the site for recycling, salvage, disposal or retention as historical artifacts.

Removal of both dams would generate more than 200,000 cubic yards of concrete, rock, and earth fill. Several surface mine or other open-pit owners in the Port Angeles area have indicated interest in obtaining materials from dam removal, and some of these are capable of accommodating the full volume of materials. The Traffic section of the environmental impact statement analyzes the impacts from transport of the debris to nine possible disposal locations. Recycling of concrete and other manufactured materials may also be possible.

Final Site Restoration. Final site restoration includes revegetation and may include the installation of recreation, public safety, and interpretive facilities. Details of final site restoration are explained in the appropriate appendix (see appendix 2, Elwha Fish Restoration Plan and appendix 3, Revegetation Plan).

Glines Canyon Dam Removal

Like Elwha Dam, removing Glines Canyon Dam includes pre-removal, removal, and post-removal restoration activities. The full activity sequence is developed in a project scheduling program (BOR 1995c; also see appendix 6) and is integrated with the removal of Elwha Dam. Since Lake Mills could be managed to provide flood protection while crews work on excavating the diversion channel for Lake Aldwell, removing Glines Canyon Dam would not begin until that diversion channel was completed to elevation 135, during July of the first construction year. A primary constraint during the sequence of activities for removing Glines Canyon Dam would be the ability to pass flows over the dam during demolition while managing sediment releases.

Pre-removal Activities – Decommissioning and Restoration Plans. For the purposes of this EIS, decommissioning is the shutdown of the power plant with continued operation of the dam prior to removal. Project decommissioning includes any work at the Glines Canyon Dam power plant required in advance of the dam removal contract work, including de-energizing the electrical equipment, removing hazardous materials, and removing the turbine runner from the main unit to permit no-load releases through the power penstock. Hazardous waste collection and disposal is discussed in the Impacts to Public Health and Safety.

As with Elwha Dam, resource protection and restoration implementation would begin one to two years before dam removal. This would include water quality and cultural resource mitigation, as well as fish restoration.

Dam Removal Activities. Although site mobilization would begin in November, Lake Mills would be used for flood control to the maximum extent possible, until the following July, to reduce flood peaks and facilitate construction of the surface diversion channel at Elwha Dam. Following completion of the surface diversion channel at Elwha Dam, removal of the arch dam section at Glines Canyon Dam would commence, with Lake Mills held at the lowest possible level during demolition.

Water elevations would be lowered to approximate elevation 523 (the crest of Glines Canyon Dam is at elevation 590) using the spillway and the power penstock. Notches for streamflow diversion would be excavated from the arch dam section at 7.5-foot increments between approximately elevations 523 and 410, using diamond-wire sawcutting in reinforced areas and controlled blasting elsewhere. An average of two blocks of 35 tons each would be removed and hauled off site each day. The reservoir would be drawn down in 7.5-foot increments about every two weeks. This two-week stable period would allow sediment in the delta at the upper end of the reservoir to redistribute and move closer to the dam. While the time period between 7.5-foot drawdowns could be increased, it could not easily be decreased.

To complement fisheries restoration and protect workers, no demolition would be performed during the periods from November 15 to December 15 and from May 1 to June 30. The lower portion of the arch dam section (including the final two lifts and the base of the dam) would be excavated in August and September of the second year during minimum stream flow. Final channel cleanup would be completed by late October.

Each structure at Glines Canyon Dam was evaluated for possible retention, based on anticipated effects on ecosystem and fisheries restoration, historic and cultural mitigation, visitor safety, maintenance costs,

Elwha River flowing into Rica Canyon. (Janis Burger photo) demolition costs, aesthetics, and opportunities for site interpretation. Structures recommended for removal from the site include the arch dam section, the penstock intake structure/trashrack tower, the surge tank tower, the transformer yard and shed, the left abutment earthfill embankment, and the boathouse. Other structures would be retained, with necessary modifications. The concrete gravity thrust block, adjoining concrete gravity section, and concrete wall on the right abutment along with the right abutment earthfill embankment are proposed to remain as a visitor view point and interpretive area (see section on Interpretation below). Retention of the spillway would provide a visitor viewpoint on the left abutment. The powerplant and penstock would be retained to provide a unique historical exhibit.

Part of dam removal would involve taking down transmission lines. The lines extend approximately 7 miles from Glines Canyon Dam to Elwha Dam (line 3), approximately 6 miles from Elwha Dam to the Daishowa America paper mill in Port Angeles, Washington (line 1), and approximately 8 miles from Elwha Dam to the Bonneville Power Administration/city of Port Angeles substation (line 2). However, only a portion of transmission line 3 from Glines Canyon Dam to the Elwha Ranger Station is proposed for removal. This is to maintain power to the site.

Final Site Restoration. Final site restoration would include revegetation and may include the installation of recreation, public safety, and interpretive facilities. Details are presented below and in the appropriate appendixes.

Sediment Monitoring and Management

Natural river processes would be, for the most part, allowed to erode the reservoir areas. Sediment management actions that would be taken include the seeding of native grasses and forbs and strategic placement of large woody debris after the dams were removed. Additional details about the movement of sediment during erosion are presented in the Impacts section.

The rate and amount of reservoir sediment erosion would depend on the dam notching rate, river and tributary flows, and the frequency and intensity of rainfall. The amount of river sediment transport would mostly depend on the river discharge and phase of the notching cycle. Monitoring of channel aggradation conditions, water quality, and fisheries restoration needs would guide some adjustments to the dam removal rate and subsequent sediment levels from Lake Mills, and is considered integral to the project (see table 5). An estimated 50% of the fine sediments in Lake Mills are expected to be removed; the remainder lies outside the floodplain or is buried in coarse delta sediment.

The sediment monitoring plan includes:

- repeat cross-section surveying along the river below the dams and in both reservoirs,
- repeat aerial photography of the river corridor and reservoir areas, and

- stream measurements of river flow, suspended sediment concentration, and turbidity at Goblin Gates, at McDonald Bridge, and below Elwha Dam.

The stream gauge immediately above Lake Mills at the mouth of Rica Canyon would be phased out and a new one established at Goblin Gates, the upstream entrance to Rica Canyon. The new gauge would be operated concurrently with the existing gauge above Lake Mills for approximately one year before beginning dam removal. The gauging station above Lake Mills would be removed upon the commencement of dam removal.

Although the gauge above Lake Mills is presently at a good location, it would be a poor quality measurement site during dam removal because of a continually eroding stream bed and difficult access. The location at Goblin Gates would be necessary to monitor the natural sediment supply during dam removal and to help guide operation of the pre-treatment facility for the industrial water supply.

Flood Control

The Lower Elwha Federal Flood Control Levee on the east side of the river near its mouth would be raised and strengthened with riprap to maintain the existing 200-year flood protection. Other flood control mitigation, specified in the Impacts section on flooding, is proposed, although not required by the Elwha Restoration Act.

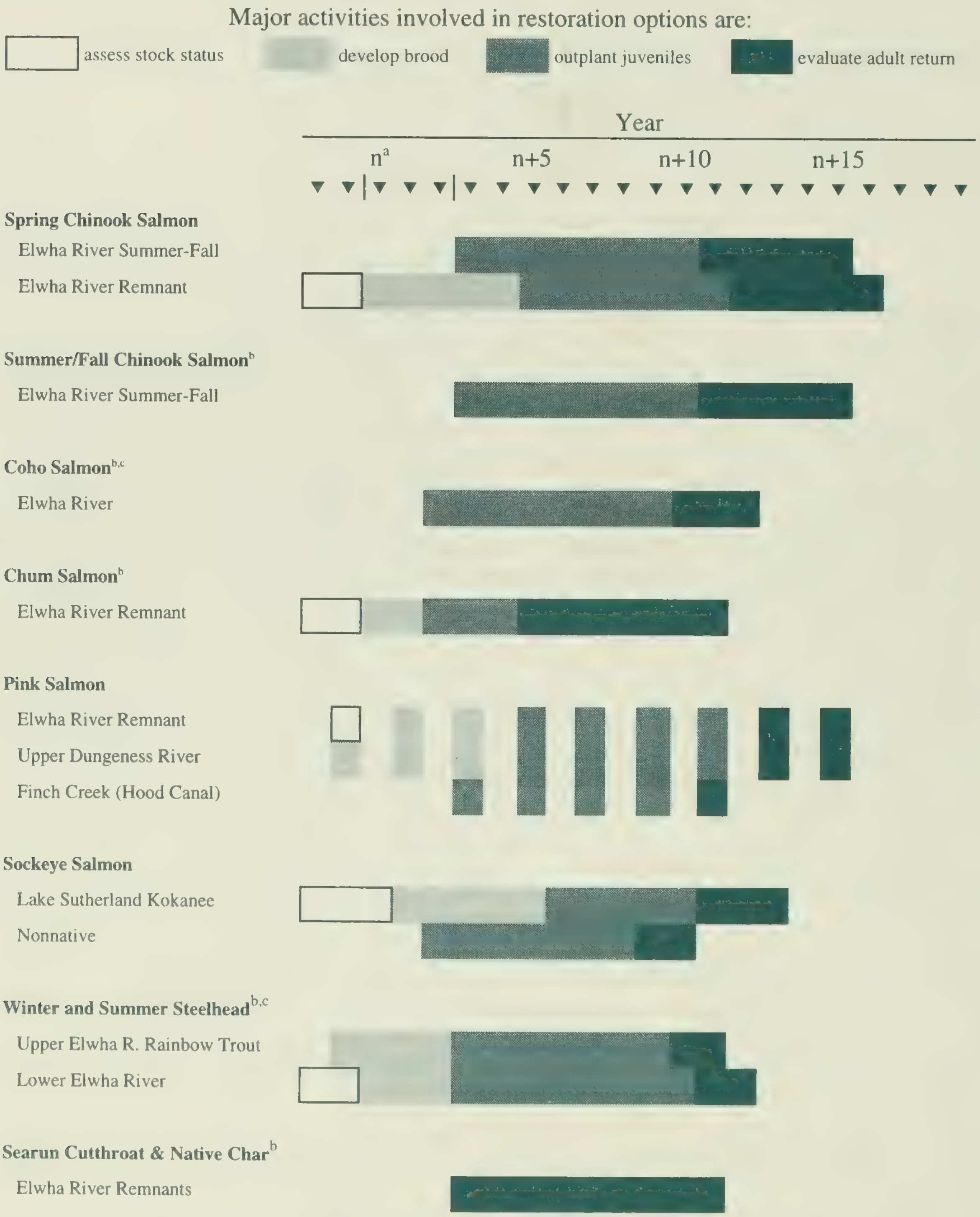
Fisheries Recovery

The recovery of Elwha River salmon and anadromous trout involves protection of stocks during dam removal and implementation of a restoration plan after removal is complete. The timelines for principal restoration options are presented in table 6.

The fish restoration plan (appendix 2) provides management guidelines for fully restoring all runs of Elwha River native anadromous fish. The plan describes actions for assessing fish stocks, developing hatchery brood, reintroducing fish by outplanting, managing harvest, and evaluating restoration efforts. Timelines and costs also are included. The 10 anadromous fish stocks that historically used the Elwha River before dam construction are addressed, including winter and summer steelhead, searun cutthroat trout, and native char (Dolly Varden and bull trout), spring and summer/fall chinook, coho, pink, chum, and sockeye salmon.

The plan emphasizes protection of lower river stocks during and immediately following dam removal. Because coho salmon and winter steelhead rear in freshwater for one and two years, respectively, outplanting of these species would begin from one to two years prior to dam removal. Outplanting of chinook and coho salmon and winter steelhead in the middle and upper river would begin when fish passage and water quality were acceptable, and continue for 10 years, depending on the stock. Pink and chum salmon would

Table 6. *Restoration Actions for Elwha River Anadromous Fish Stocks*



[a] "n" represents the first year of construction impact to fish, i.e. the drawdown of Lake Aldwell. "n+5", "n+10", etc. is five years or ten years after the first year of impact. The two vertical lines represent the construction period.

[b] Natural recolonization is expected to occur in conjunction with any planned outplanting

[c] Outplanting may occur one year (coho) to two years (steelhead) before complete dam removal to allow for natural rearing

be outplanted in the middle and lower river. Sockeye salmon (from Lake Sutherland kokanee), summer steelhead (from upper river resident rainbow trout), searun cutthroat trout, and char would be allowed to restore naturally.

Outplanting methods would vary by location (see appendix 2). Above river mile 16 fish stocks would be outplanted by helicopter because of lack of road access. Below river mile 16 outplanting would be done by conventional tank truck and from the hatchery facilities.

Hatchery support would be necessary to develop broodstock for juvenile outplanting and to maintain existing fish production levels during the rebuilding period. The hatchery and rearing channel in the lower river and out-of-basin facilities (Sol Duc and Dungeness hatcheries) would be used to produce juvenile fish for outplanting. Modifications to the Elwha facilities would include improvements to water supplies and upgrades in incubation, rearing, and support capabilities. These would incorporate innovative hatchery practices that simulate natural rearing conditions and potentially improve survival in the wild. The use of the Washington Department of Fish and Wildlife facility in the lower river would be precluded by high sediment concentrations for about two years during dam removal. A rock check dam now used to divert surface water to industrial users (mills) would be removed to ensure full passage.

For those species and stocks for which there are no viable populations in the Elwha system, other fish stocks are being assessed to identify and develop the most promising sources of broodstock for restoration. This assessment is now being done so that sources would be available for outplanting at the first opportunity.

Adaptive management would be employed. Adult returns would be monitored and reintroduction strategies modified as appropriate. During the reintroduction period, in–river harvest of the recovering stocks would be curtailed only if necessary to meet adult escapement goals.

Summaries of restoration activities for each fish stock are presented below.

Spring Chinook Salmon – Outplant eggs and young-of-the-year progeny of early returning summer/fall chinook salmon during early spring above Carlson Canyon. Over time, spring return characteristics would be exhibited.

Summer/Fall Chinook Salmon – Release fry, fingerling, and smolt from the Washington Department of Fish and Wildlife rearing channel, and outplant the same in the middle river.

Coho Salmon – Release coho smolts from the tribal hatchery and outplant eggs and young-of-the-year fish to the upper river from existing lower river stock.

Winter Steelhead – The existing late – run lower river stock would be outplanted as young-of-the-year or pre-smolts in the upper river. The resident upriver rainbow population (believed to be remnant Elwha steelhead) currently produces smolts that migrate downriver. These fish would return as adults and contribute to steelhead restoration.

Summer Steelhead – Rely on natural recolonization by upriver rainbow trout stock (believed to be remnant Elwha steelhead).

Pink Salmon – Assist in the recovery of the nearby Dungeness River stock, and outplant as fry and/or place eggs in remote site incubators in the middle and lower river.

Chum Salmon – Develop brood from existing lower river stock. Outplanting would be the same as for pink salmon.

Sockeye Salmon – Rely on natural recolonization by Lake Sutherland kokanee after dam removal.

Searun Cutthroat and Char – Rely on natural recolonization by remnant lower and upriver stocks.

Revegetation

The revegetation goal for the Lake Mills and Lake Aldwell lake beds would be to restore the areas to the conditions and processes that existed prior to the construction of the dams. Krause Bottom, upstream from Rica Canyon, provides a model of plant communities similar to those believed to have occurred within the former lake beds. Sweets Bottom, located between the two dams, also provides a visual model of an open, flat, terraced community, although it has been modified by settlement and clearing. The distribution and composition of native plant species within these two areas, as well as the plant communities on the slopes above the reservoirs, were used in the development of the revegetation plan.

The lake beds would be revegetated through a combination of natural recolonization and a moderately intensive program of planting native species. The dispersal of seeds from upslope and upstream areas would result in a natural reseeding of the lake beds. To accelerate succession, achieve a structurally complex forest ecosystem in a shorter time period, and limit invasion of non-native species, a variety of planting schemes would be used (see appendix 3). Methods would include seeding, use of cuttings, and planting trees of different ages. Fertilizer would be applied with selected individuals to encourage rapid stand development, and species composition would be varied to reflect plant communities on a landscape scale. Additional treatments may include placement of large organic debris and inoculating planting stock with mycorrhizal fungi. Plant materials would be collected only from the Elwha valley to maintain genetic integrity of the ecosystem; planting stock would be propagated prior to dam removal. Nonnative plant species that colonize the lake beds would be controlled or eradicated. The success of natural recolonization and planting would be evaluated annually to determine necessary modifications or remedial measures. Such measures could include the replanting of areas where survival was poor, or manipulating stand density to better achieve goals.

The revegetation program would use a wide variety of native ferns, grasses, forbs, shrubs, and tree species including, but not limited to, vanilla leaf, sedge, sword fern, salmonberry, salal, Oregon grape, willow, bigleaf maple, red alder, western hemlock, Douglas-fir, and western red cedar. Individual site conditions would dictate the mix of plant species used. In wetter areas sedges, lady fern, salmonberry, black cottonwood, willow, red alder, grand fir, bigleaf maple, and western red cedar would be seeded or planted. Upslope forest species would include sword fern, native roses, huckleberry, Oregon grape, salal, western hemlock, western red cedar, and Douglas-fir. Additional details of the revegetation plan are in appendix 3.

Water Quality Protection

The river erosion alternative would result in periods of very high suspended sediment (silt and clay-sized particles) and bedload transport of sand and gravel. As a part of the Elwha Restoration Act, actions are to be considered to protect water quantity and quality for municipal and industrial water users.

Surface water quantity below Glines Canyon would not be altered by the proposed action, with the exception of a few high flow months during year one of the project. Flood flows would be somewhat moderated below Glines Canyon for two to three months to reduce flooding during construction of the diversion channel at Elwha Dam. Groundwater yield from some near-river wells might be altered in the short term by increases in fine sediment within the aquifer.

To provide for existing water supplies various repairs, upgrades, and short-term treatments are proposed for the existing water systems (table 7). The facilities would be in place and operating before dam removal begins.

Disposition of Lands

Lands acquired at the Glines Canyon Damsite would become part of Olympic National Park and be managed in accord with park policies. The majority of the area would be classified as a natural zone, managed under backcountry/wilderness guidelines. It is expected that this area would be designated wilderness in the future in Opportunity Class IV, or Pristine. This means that wilderness conditions, including ecosystem processes and use-related impacts, would be restored to as pristine a level as practicable. Class III, or a Primitive designation, would be limited to a trail corridor between Boulder Creek and Cat Creek and the area at the mouth of Cat Creek, where camping would be permitted on the gravel bars. The West Lake Mills Trail would be retained, with two to four campsites at the trail's end restored to wilderness standards. Some of the hydropower facilities at Glines Canyon would be left intact (see below) to provide interpretive opportunities or preserve important historic

structures.

The Elwha Act specifies that Aldwell lands should be studied for inclusion in the national wildlife refuge system or the national park system or for transfer in trust to the tribe "for tribal housing, cultural or economic development purposes in accordance with a plan developed by the Tribe in consultation with the Secretary," or for "development and use by the State."

The US Fish and Wildlife Service has indicated that the Aldwell land area would be too small to support a wildlife refuge and is not interested in managing the lands for that purpose. The park has stated that the lands qualify for inclusion in the park; adding them would require an act of Congress. The Washington Department of Natural Resources has stated that it is not interested

Table 7. *Water Quality Mitigation Measures*

	PART OF ALTERNATIVE
Industrial Supply	Infiltration gallery/diversion modifications Open channel pre-treatment
City Water	New Ranney well — west bank Temporary iron treatment/filtration
Tribe	Upgrade hatchery infiltration gallery Supplemental wells
Dry Creek WA	Connect to Ranney system **and** new treatment (Cl, filtration) system **or** modification to existing wells and system
	RECOMMENDED MITIGATION
Tribe	Mound sewage treatment
Elwha Place Homeowners' Association	Flood proof existing wells Temporary in-line treatment system
Well owners upstream of 101	Temporary in-line filtration, bottled water
Well owners upgradient of Lake Aldwell	Drill new wells
Well owners in river valley	Raise and modify well heads
All well owners (private)	Contingency fund ($150,000)
State rearing channel	Offsite rearing Wellhead protection

in acquiring the exposed lands if adequate provisions for public access are made (DOI 1995, comment letter). The department may pursue a possible cooperative management effort with the tribe.

The Lower Elwha Klallam Tribe is interested in acquisition of the lands. They have prepared a preliminary land use plan that leaves the river and floodplain protected as a conservation area with suitable uplands managed for natural resources, residential use, and/or economic development. A primary tribal objective is to restore the river's fishery and ecosystem — any use of project lands must be compatible with this objective. Activities on conservation lands would include fishing, hiking, hunting, and gathering of traditional cultural resources, as well as restoration efforts. In natural resource areas, activities may include riparian and viewshed protection, primitive recreation, selective timber harvest on long rotations, vegetative management for cultural resources, and wildlife management. Residential and economic development areas may include tribal housing and businesses.

Interpretation

Creating interpretive opportunities at both damsites is being investigated as part of possible mitigation for removal of the historic hydroelectric structures. Interpretation would include parts of the Glines Canyon project left in place, wayside exhibits explaining key physical and biological (revegetating areas) features, and documentation of dam removal and ecosystem restoration.

Within the park, each piece of the Glines Canyon project has been evaluated for its value as an interpretive historic resource. Several structures would be left standing, including the powerhouse, spillway, penstock, and gatehouse. A concrete thrust block on the east side of the dam would provide an excellent view of the project area, and would be retained.

The spillway provides significant historical mitigation and interpretation opportunities. Long-term maintenance would be minimal. Some modifications would be necessary for visitor safety, such as improved guardrails (e.g., wire mesh to prevent children from climbing through the guardrails) and measures to prevent people from reaching the spillway chutes by climbing over the spill gates.

The penstock offers significant historical mitigation and interpretation opportunities, with minimal maintenance costs. To provide interpretive opportunities and be included in an interpretive trail, the wooden stairway on top of the penstock would need to be replaced with a low-maintenance, metal stairway. The penstock would probably need to be painted.

The gatehouse offers historical mitigation and interpretation opportunities. If retained, the windows and door would be removed to prevent vandalism and the wooden stairway replaced with a low-maintenance metal stairway. Electrical wiring and wooden power poles would be removed. The guardrail would need modification to increase visitor safety. A final decision whether to retain this structure would require further review.

Although the boathouse offers no retention benefits and would be removed, the two houses and maintenance shed could provide needed office and storage space during deconstruction; they might remain for a short time.

The powerhouse offers significant historical mitigation and interpretation opportunities. The windows would be replaced with wire mesh and all hazardous wastes, if any, removed. The metal shed at the site would be removed.

Glines Canyon Dam penstock and surge tank, no date. (Daishowa Company photo)

Cultural Resources

Lower Elwha Klallam sites would be made accessible for the first time in 80 years. Two historic dams would be removed. There would be an increased threat of loss for archeological sites, and historic sites such as the Elwha Ranger Station Historic District. The cultural resource mitigating measures listed in table 8 would be implemented in compliance with Section 106 requirements of the National Historic Preservation Act.

Costs

Costs are presented in table 9. Costs of recommended mitigation are included in these totals.

Permitting

Numerous federal, state, and local permits and review processes are required to implement the proposed action. This document is part of one of those processes, the National Environmental Policy Act of 1969. Required permits are presented in appendix 6. Project permitting costs are included in the final design costs.

The Washington State Department of Ecology regulates water quality under the Clean Water Act. The Department of Ecology also regulates water quantity with water rights for water withdrawals and permits temporary modifications of water quality criteria. The Safe Drinking Water Act and Washington Administrative Code 173-201A also set drinking water standards. The proposed action would be in compliance with these requirements.

The Elwha River Restoration Act authorizes the secretary of the interior to implement actions to protect municipal and industrial water supply and quality. The proposed action would mitigate the increased levels of turbid waters with water treatment facilities and upgrades to water intakes where appropriate. These facilities and upgrades would meet appropriate water quality standards for water supplies, providing protection from the turbid waters during and following dam removal.

Table 8. *Mitigation Measures Required under the Interagency Programmatic Agreement and Section 106 of the National Historic Preservation Act*

IMPACT	MITIGATION
Erosion from increased river meander	Monitor, stabilize bank, or data recovery
Loss of tribal cultural properties	Survey, monitor, response plan
Erosion of terraces	Monitor, stabilize bank, or data recovery
Aggradation and flooding	Monitor, stabilize bank, data recovery or recording of significant features
Loss of historic projects (dams)	HABS/HAER recording of significant features, retain some elements on site, interpretation
Grading of roads	Survey prior to ground disturbance, avoid or data recovery
Disposal of waste rubble	Survey prior to dumping, response plan
Revegetation (digging may uncover resources)	Survey, response plan

The Clean Water Act, Section 404, and the Rivers and Harbors Act, Section 10, address project dredge and fill areas, specifically for excavation in streams or wetlands, which includes structure removal and water intake upgrades. Construction in and near the Elwha River is reviewed under the State Shoreline Management Act and requires a Hydraulic Project Approval from the Washington State Department of Fish and Wildlife. The proposed action would be in compliance with these requirements.

Dredge and Slurry Alternative

Summary of Actions

Features of the Dredge and Slurry alternative include:

- removing features of the dams necessary to restore fish passage and ensure public safety
- dredging of some fine-grained reservoir sediments and transporting to the ocean by pipeline
- restoration of historic anadromous fish runs
- revegetation of the reservoir areas
- monitoring of sediment transport and river channel topography, water quality, and aquatic ecology
- short and long-term protection of municipal and industrial water supplies from adverse effects of dam removal
- mitigation of flood impacts to Lower Elwha Klallam Reservation residents caused by long-term river aggradation

Table 9. *Cost Estimates — River Erosion Alternative (Proposed Action)*

ACTIVITY	REFERENCE YEAR (BUDGET YEAR) (costs in thousands of dollars)						
	Total	n-2 (1)	n-1 (2)	n (3)	n+1 (4)	n+2 (5)	Balance to Complete
Project Acquisition							
Direct Acquisition Cost	29,500	29,500					
Other Lands & Rights Costs	300	250	50				
Subtotal	**29,800**	**29,750**	**50**				
Engineering Design							
Preconstruction Data Collection	458	458					
Decommissioning of Projects	30	30					
Water Quality Protection	1,531	1,523					8
Flood Protection	368	295					73
Dam Removal	800	300	500				
Haz Waste Cleanup	53	45		8			
Transmission Line Removal	10				10		
Road Rehabilitation	48				48		
Hatchery Expansions	405		320	85			
Subtotal	**3,703**	**2,651**	**820**	**93**	**58**		**81**
Direct Construction Costs[a]							
Decommissioning of Projects	300		300				
Water Quality Protection	24,788	10,240	14,398				150
Salvage of Water Treatment Equipment	(225)						(225)
Flood Protection	3,630		1,140	1,765			725
Dam Removal	20,200			9,200	10	1	
Haz Waste Cleanup	534		200		334		
Transmission Line Removal	650					650	
Road Rehabilitation	480					480	
Hatchery Expansions	4,040		3,180	860			
Subtotal	**54,397**	**10,240**	**19,218**	**11,825**	**10,334**	**2,130**	**650**
Construction Management	8,490	1,920	2,560	1,580	1,537	760	133
Waste Disposal Fees	1			500	500		
Sediment Management/WQ Monitoring	1,894		100	610	460	320	404
Sediment Modeling	100	70	30				
Cultural Resources	665		151	162	167	74	111
Fish Restoration	2,685	91	166	199	226	237	1,766
Revegetation/Wildlife	3,205		885	565	560	560	635
Marine Resources Monitoring	150	10	20	20			100
Construction Related O & M Costs							
Glines Canyon and Elwha Dams	1,100	500	500	100			
Water Treatment Facilities	3,676			412	1,088	1,088	1,088
Dredge Hatchery Outlet	250				50	100	100
Subtotal	**5,026**	**500**	**500**	**512**	**1,138**	**1,188**	**1,188**
TOTAL	**111,115**	**45,232**	**24,500**	**16,066**	**14,980**	**5,269**	**5,068**

[a] Includes those items subject to design and construction management allowances.

Note: The preceding cost estimates are refined from those contained in the restoration project programmatic FEIS. These costs will be further refined when final project designs are developed. Generally, these further refinements can be expected to reduce costs as design constraints become more certain and contingencies are reduced accordingly. In addition, application of value engineering procedures have the potential to further reduce costs at the final design stage. A less probable likelihood is that costs could increase due to some as yet unforeseen cost element.

Costs at April 1995 Price Level Revised: 17-Oct-95

- reservoir drawdown in controlled increments with periods of constant lake elevation in between
- short-term protection of native fish stock

Dam Removal

Dam removal plans under this alternative would be essentially the same as those described under the proposed action.

Sediment Management

The Dredge and Slurry alternative would focus on reducing downstream suspended sediment concentration and turbidity by dredging lake bed sediments from Lake Aldwell and Lake Mills before they could erode downstream. Fine sediment (silt and clay) would be transported through the slurry pipeline to the Strait of Juan De Fuca near the mouth of the Elwha River. Natural offshore currents would then transport these sediments toward Ediz Hook. The outfall would be located where the strong currents of the strait would rapidly disperse the sediment. The outfall could be at a fixed location, either submerged or on the water surface, or the outfall could be movable. The best outfall location, considering the impact of fine sediment on marine resources, would be north of Angeles Point at a water depth of 50 to 100 feet, approximately 1 mile from the shoreline.

Coarse delta sediments would be allowed to erode since they are considered to be a resource necessary to restore fish habitat downstream. The coarse sediments would be transported primarily as bedload and would not be as likely to increase turbidity as would fine sediments.

Each reservoir would be drawn down in the same manner as described under the River Erosion Alternative. Dredges working 24 hours a day from barges would pick up lake bed sediments immediately downstream from the progressing delta front for transport into the sediment slurry pipeline. A majority of the lake bed sediments within the pre-dam 100-year floodplain would be removed. The remaining portion would be allowed to stabilize within the reservoir.

Minimum river flows would have to be maintained during dam and reservoir sediment removal. Slurry pipeline operation would be temporarily discontinued if the water required for the slurry mixture resulted in river flows too low for fish and downstream water users.

Two problems with dredging are possible. First, the reservoir sediment dredging operation would need to avoid the large amount of woody debris along the reservoir bottom and shoreline. Second, although silt- and clay-sized sediments are expected to easily flow by gravity through the sediment slurry pipeline, sand-size and larger sediment may clog it. To alleviate the problem in Lake Mills, dredged lake bed sediment would be pumped to a settling basin or separator near the Glines Canyon Dam forebay and then into the sediment slurry pipeline. A settling basin or separator would be used to prevent sand and coarser material from entering and plugging the slurry pipeline. Coarse material would be discharged back into the reservoir.

Pipeline

The sediment slurry would flow by gravity where possible to minimize pumping costs. Gravity flow would not be a problem if the pipeline route closely followed the steep channel of the Elwha River. However, the river flows through narrow bedrock canyons below each damsite; in these canyons, pipeline construction and maintenance would be difficult.

The Dredge and Slurry alternative would focus on reducing downstream suspended sediment concentration and turbidity ...

Except for road crossings, the pipeline in the upper part of the river would be mostly above ground. The pipeline would be steel or high density polyethylene, with diameters ranging from 26 to 42 inches. Lateral supports could be needed approximately every 60 feet along the road. Supports would be required in the river channel to prevent the pipeline from floating during flood stage or moving against sharp rocks. Supports might consist of large concrete blocks or rock anchors. The pipeline would be removed after lake bed sediments had been dredged from each reservoir.

From Lake Mills, the pipeline would be routed along the Olympic Hot Springs Road to a point near the McDonald bridge stream gauge (see figure 6). Since the road is narrow (approximately 22 feet), some widening would be necessary to provide room for the pipeline. The pipeline would then be routed into the river channel, under the Highway 101 bridge, and floated on Lake Aldwell to another settling basin near the Elwha Dam forebay. The settling basin would allow dredged sediment from Lake Aldwell to enter the slurry pipeline.

From Elwha Dam to the strait, two pipeline routes are possible. One would use gravity flow through the canyon below Elwha Dam; the other, aligned under county roads, would require pumping (the cost table for this alternative assumes the second alignment (B) would be used). The first, Alignment A, which takes advantage of gravity flow, would either follow the river or travel along the top of the lower Elwha flood control levee to the east end of Freshwater Bay. In salt water, the pipeline would be submerged by intermittent anchoring devices such as sand bags, concrete blocks, or cables. The outfall end of the pipeline would be movable, allowing relocation to various sites if needed to optimize sediment distribution, adjust to changes in nearshore currents, or accomplish other objectives.

The other alignment (B) would follow all county roads from Elwha Dam. The line would be buried for the entire route — along the Lower Dam access road to Highway 112, east on Power Plant Road, north on Laird Road, east on Edgewood Drive, and north and west on Lower Elwha Valley Road to the mouth of the river. The entire 6.5 miles of roadway would be replaced after the line was buried. A plant with five equal sized pumping units at Elwha Dam would be required for this alignment.

Flood Control

Flood control measures would not change from the proposed action.

Fisheries Recovery

Fisheries recovery measures would not change from the proposed action.

Water Quality Protection

Even with the slurry pipeline, impacts to water quality from the fines that would wash downstream would still need mitigation. Industrial water quality facilities would be the same as needed for river erosion; however, they would not be used as intensively because sediment concentrations would be approximately 25% of those under the river erosion alternative. Fine sediments washed downstream would decrease by an estimated 4 million cubic yards, over one to two years, when compared with the proposed action. About 1.2 to 2.6 million cubic yards of fine sediment in the deltas would still wash downstream as the deltas eroded. Fines from the lakebottom floodway areas that could not be dredged would also wash downstream. Because of these differences, operation and maintenance costs of industrial water quality protection are estimated as less for this alternative.

Since impacts from iron and manganese released from pore spaces within the lakebed sediments would be reduced (see Impacts to Groundwater), some treatment systems for groundwater users would be scaled back or eliminated. These include a recommended temporary treatment system for the Elwha Place Homeowners' Association (if the River Erosion alternative is selected), and possibly a filtering system for the Port Angeles Ranney collector supply (considered integral to the proposed action).

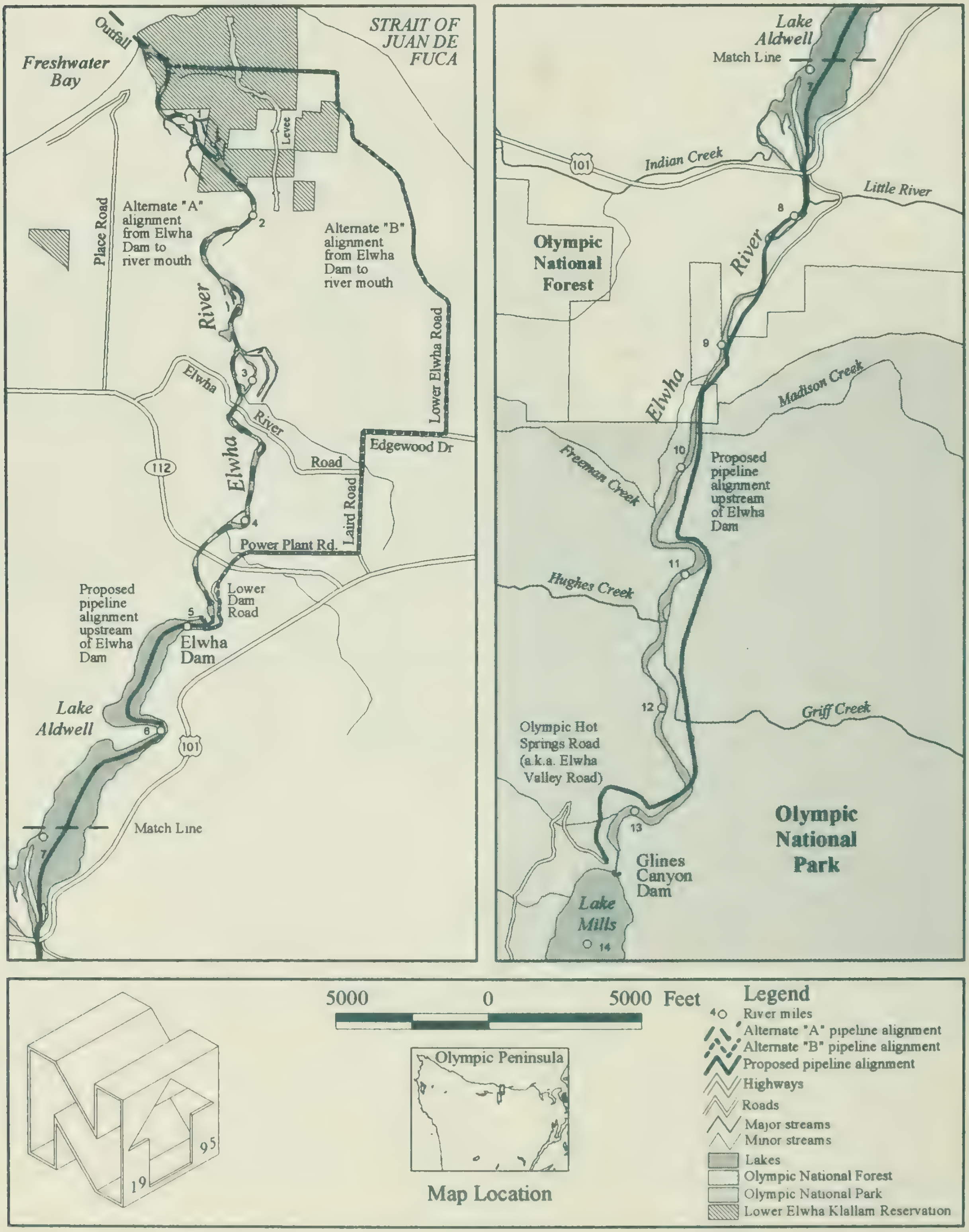
Disposition of Lands

Disposition of lands would be the same as under the proposed action.

Interpretation

Interpretation would be the same as under the proposed action.

Figure 6. *Dredge & Slurry Pipeline Route*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20067



Cultural Resources

Cultural resource mitigation is the same as in the proposed action except for the addition of the following:

Impact	**Mitigation**
1. Grading of pipeline route	1. Survey and avoid or recover data
2. Burying sites at outfall	2. Survey; response plan
3. Dredging may uncover reservoir sites	3. Monitor; avoid or data recovery

Costs

Costs for this alternative are summarized in table 10. Dredging costs would be directly related to the quantity of material removed. Lakebottom sediment density also would affect dredging rates and removal costs; dredging energy and time requirements are higher for denser materials. Bureau of Reclamation techniques based on the number of years of impoundment and grain size distribution indicate that the dry weight of lake bed material is approximately 70 pounds per cubic foot, or 40% solids. Since no sampling of lakebottom sediment density was undertaken for this study, cost estimates are based on a conservative assumption that there is a solid material density of 60% (100 lb/ft^3).

No right-of-way acquisition for placing the pipeline is anticipated. Temporary easements may be required for construction and placement of the pipe. The alignment uses public rights-of-way for the entire length. The Olympic Hot Springs Road is owned by the National Park Service. The Washington Department of Natural Resources controls river bottom where the pipe would be placed. Two basic alignments were considered. Alignment A uses the Elwha River right-of-way and Olympic Hot Springs Road, while alignment B uses

Elwha River near Olympic Hot Springs Road. (Charles Scott photo)

Table 10. *Cost Estimates — Dredge and Slurry Alternative*

ACTIVITY	REFERENCE YEAR (BUDGET YEAR) (costs in thousands of dollars)						
	Total	n-2 (1)	n-1 (2)	n (3)	n+1 (4)	n+2 (5)	Balance to Complete
Project Acquisition							
Direct Acquisition Cost	29,500	29,500					
Other Lands & Rights Costs	300	250	50				
Subtotal	**29,800**	**29,750**	**50**				
Engineering Design							
Preconstruction Data Collection	481	481					
Decommissioning of Projects	30	30					
Water Quality Protection	1,379	1,371					8
Flood Protection	368	295					73
Slurry Pipeline[b]	1,120	1,120					
Reservoir Dredging	100	100					
Dam Removal	800	300	500				
Haz Waste Cleanup	53	45		8			
Transmission Line Removal	10				10		
Road Rehabilitation	48				48		
Hatchery Expansions	405		320	85			
Subtotal	**4,794**	**3,742**	**820**	**93**	**58**		**81**
Direct Construction Costs[a]							
Decommissioning of Projects	300		300				
Water Quality Protection	21,943		16,815	4,978			150
Salvage of Water Treatment Equipment	(225)						(225)
Flood Protection	3,630		1,140	1,765			725
Slurry Pipeline[b]	11,728		11,728				
Reservoir Dredging	9,136			4,568	4,568		
Dam Removal	20,200			9,200	10,000	1,000	
Haz Waste Cleanup	534		200		334		
Transmission Line Removal	40					40	
Road Rehabilitation	480					480	
Hatchery Expansions	4,040		3,180	860			
Subtotal	**71,806**		**33,363**	**21,371**	**14,902**	**1,520**	**650**
Construction Management	8,990	1,920	3,000	1,700	1,477	760	133
Waste Disposal Fees	1,000			500	500		
Sediment Management/WQ Monitoring	1,594		100	550	400	260	284
Sediment Modeling	100	70	30				
Cultural Resources	665		151	162	167	74	111
Fish Restoration	2,685	91	166	199	226	237	1,766
Revegetation/Wildlife	3,205		885	565	560	560	635
Marine Resources Monitoring	150	10	20	20			100
Construction Related O & M Costs							
Glines Canyon and Elwha Dams	1,100	500	500	100			
Water Treatment Facilities	890			270	450	130	40
Electricy for Lake Dredging	412			206	206		
Dredge Hatchery Outlet	250				50	100	100
Subtotal	**2,652**	**500**	**500**	**576**	**706**	**230**	**140**
TOTAL	**127,441**	**36,083**	**39,085**	**25,736**	**18,996**	**3,641**	**3,900**

(Table 10 footnotes on following page)

Olympic Hot Springs Road and other roads mostly under Clallam County right-of-way.

The cost estimate for alignment A is $16.9 million. The cost estimate for alignment B, which includes pumping costs and placing permanent pipes under Clallam County roads, is $21.1 million. Table 10 is conservative in assuming the most costly alignment (B).

In addition to these capital costs, Daishowa America would pay about $2 million more per year for the 38% of its power now supplied by the projects (see Impacts to Socioeconomics).

Permitting

Permitting is similar to the river erosion alternative with the addition of construction permits and leases or easements required for construction and operation of the slurry pipeline. The slurry pipeline along and under roads would require traffic interruptions requiring coordination with the state and county road departments.

The river pipeline alignment involves lands controlled by the Washington Department of Natural Resources and Department of Fish and Wildlife. Discharge of the slurry would require a National Pollution Discharge Elimination System permit (NPDES) under the Clean Water Act administered by the Washington Department of Ecology. Temporary placement of the pipeline in the ocean may also require compliance with the River and Harbors Act.

The pipeline route for the road alignment option would fall almost entirely within the limits of the county right-of-way, except where the line passed under Highway 112, a Washington State highway right-of-way. As long as installation followed standard practices and met design and construction requirements, no permits would be required from county and state agencies.

Alternatives Considered but Rejected

The narrowing down of a range of alternatives involved many steps. To meet the requirements of the National Environmental Policy Act, all alternatives

(Table 10 continued from previous page)

a Includes those items subject to design and construction management allowances.

b Uses overland route for pipeline to facilitate maintenance of slurry pipeline regardless of river flow; provides for discharge of sediment 1 mile offshore. Using Alignment A would reduce total cost by $4.2 million.

Note: The preceding cost estimates are refined from those contained in the restoration project programmatic FEIS. These costs will be further refined when final project designs are developed. Generally, these further refinements can be expected to reduce costs as design constraints become more certain and contingencies are reduced accordingly. In addition, application of value engineering procedures have the potential to further reduce costs at the final design stage. A less probable likelihood is that costs could increase due to some as yet unforeseen cost element.

Costs at April 1995 Price Level Revised: 24-Oct-95

Table 11. *Summary of Alternatives*

	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Dams	Operation of Elwha and Glines Canyon Dam would continue.	Removal of features of both Elwha and Glines Canyon dams necessary to fully restore the ecosystem and fisheries of the Elwha River would occur over a 24-month period.	Same as Proposed Action
Sediment Management and Monitoring	Sediment would continue to accumulate behind the dams.	Natural river processes would be allowed to erode the reservoir areas; Dam removal would be phased to reduce sediment levels during some periods to help protect fish; River sediment processes would be monitored to help control dam demolition rates.	Downstream suspended sediment concentrations would be reduced by dredging lakebed sediments and transporting through a slurry pipeline to the Strait of Juan De Fuca. Dam removal phasing and monitoring would be the same as for the proposed action.
Flood Control	No new flood control measures.	The Lower Elwha Federal Flood Control Levee would be raised and strengthened to maintain existing levels of flood protection. Other flood control mitigation is recommended although not required by law.	Same as proposed action
Fisheries	Fisheries partially maintained by hatcheries	Hatchery support, outplanting, harvest management, and optimal timing of dam removal would be used to help protect anadromous fish populations during the dam removal process and accelerate full restoration.	Same as proposed action
Revegetation	No revegetation	Reservoirs would be revegetated to restore pre-dam conditions and processes.	Same as proposed action
Water Quality Protection	Filtration and chlorination for municipal and/or industrial supplies	Infiltration gallery and pre-treatment for industrial supplies; new Ranney well for municipal supply (including Dry Creek Water Association). Other treatments (filtration, new wells, mounded septic system, raised wellheads, contingency funds etc.) recommended for EPHA, Lower Elwha Klallam Tribe and individual well users.	Water quality facilities would generally be the same as the proposed action except that Fe/Mn treatment and filtration would not be required and the industrial pre-treatment would not be used as intensively.

	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Disposition of Lands	All project lands would remain in existing ownership (James River Corporation).	Lands acquired at the Glines Canyon Damsite would become part of Olympic National Park. Aldwell lands would be managed by the park, Washington state or held in trust for Lower Elwha Klallam Tribe.	Same as proposed action
Interpretation	No changes in interpretation.	Interpretation would include leaving parts of the Glines Canyon project in place, wayside exhibits explaining key historic events in the construction of the dams, physical and biological features, and documentation of dam removal and ecosystem restoration.	Same as proposed action
Cultural Resources	No cultural resource mitigation occurs.	Cultural resource mitigating measures (avoidance, survey, documentation, monitoring) would occur in compliance with the Section 106 requirements of the National Historic Preservation Act.	Same as proposed action except with additional measures to mitigate impacts of dredging and construction of the slurry pipeline.
Costs	$1.0 to 1.5 million per year to operate; $8.7 million for future repairs; $100,000 per year indirect costs to maintain Ediz Hook; $480,000 total hatchery costs per year.	$111.1 million total cost over an 18-year period plus increased power costs for Daishowa.	$127.4 million total cost over an 18-year period plus increased power cost for Daishowa.
Permitting	It is unknown how FERC licensing would be resolved. Litigation would probably resume.	Numerous federal, state, and local permits and review processes would be required. Several permits required for compliance with Clean Water Act sections.	Same as proposed action except with additional reviews for construction and operation of the slurry pipeline.

must be technically and economically feasible and display common sense. Many alternatives were eliminated because they did not meet one or all of these criteria.

The EIS team assumed that the alternatives which accomplished the same goals and had the same impacts were duplicative; the less expensive of these duplicative alternatives was usually chosen for further analysis.

Also, all alternatives must meet project objectives or goals. These objectives were formulated by the EIS team and were based on scientific, regulatory, policy and legal requirements, and public input. The Purpose and Need chapter lists the broad goals developed by the team. However, many more specific objectives were developed, and these helped define the reasonableness of an alternative.

Alternatives involving removal of one dam or the other and/or fish passage measures were analyzed in the previous programmatic EIS. The secretary of the interior has chosen to implement full dam removal to restore the Elwha River ecosystem, therefore these alternatives are not relevant to this EIS.

Dam Removal

Elwha Dam

Elwha Dam, 1995. (Maggi Johnson photo)

The EIS team examined an option at Elwha Dam which would have left in place most of the dam and all of the fill placed behind the dam to stabilize it after its foundation failed in 1912. A channel excavated through the bedrock of the left abutment would have created a new river alignment through which fish could swim. The Lower Elwha Klallam Tribe noted this would prevent use of some of the land and would continue to prevent access to an important cultural resource, the creation site of the Elwha people. The left abutment bedrock outcrop itself is also a significant cultural resource to the tribe. This minimum removal alternative would not return the channel to its pre-dam configuration, one of the objectives developed by the EIS team. For these reasons, this alternative was eliminated.

Both the FERC *Draft Staff Report* (1993) and the 1994 *Elwha Report* examined building a tunnel to drain Lake Aldwell; one through the left abutment (FERC) and one through the right (*Elwha Report*). A lake tap and gate shaft would be installed to control flows, and the reservoir would have been drawn down in stages. The diversion tunnel alternative was believed to afford a large degree of downstream safety during the dam removal and sediment control (although it could plug with logs and sediment). It was considered because reservoir levels could be controlled and safely pass high flows while minimizing chances for uncontrolled release of water and sediment through the potentially unstable channel fill materials.

The estimated cost for the diversion tunnel and structure removal was $14.53 million (1992 dollars), compared to $8.59 million for a diversion channel. Recent

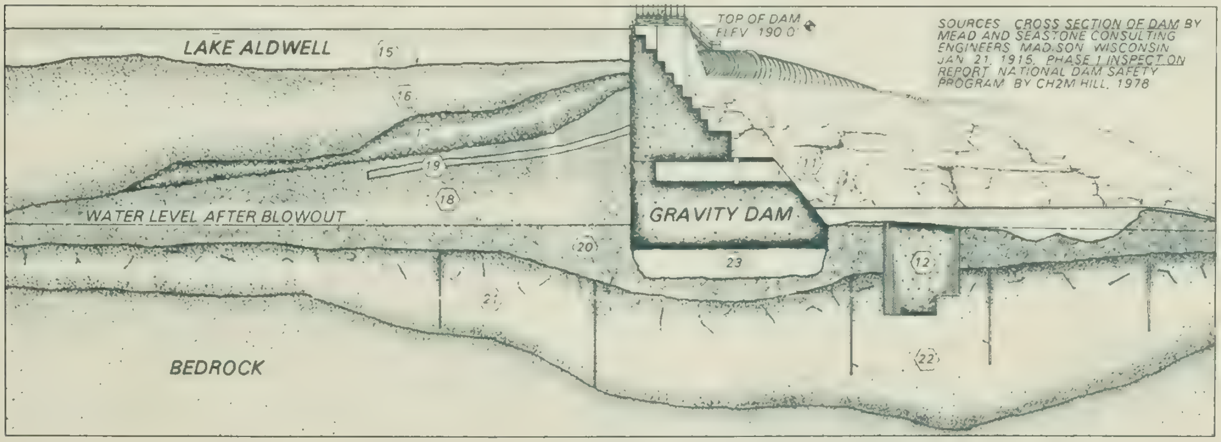
Bureau of Reclamation experience with a similar tunnel at the Theodore Roosevelt Dam in Arizona led to the conclusion that $14.53 million was an underestimate of costs. In addition to cost, the bedrock is recognized by the Lower Elwha Klallam Tribe as a cultural resource. The Bureau of Reclamation identified significant safety risks associated with construction of the tunnel. Since other streamflow diversion methods would be technically feasible at a lower cost, the diversion tunnel alternative was eliminated.

A major concern for the removal of Elwha Dam is the potential instability of the fill materials placed to plug the initial breach under the dam and cut off seepage during its early history (1912–1919). A failure of the alluvium that supports the dam foundation similar to that in 1912 could recur during removal. Although the concrete gravity section would probably remain (as it did in 1912), the rapid, uncontrolled release from the reservoir might be catastrophic.

An option was considered to reduce seepage flow by driving large diameter (5- to 6-foot) piles through the channel fill at the upstream face of the dam and into the bedrock. Advancing the piles through the rockfill, boulders, and logs in the channel fill could have been very difficult, and its effectiveness in controlling seepage beneath the dam would probably be minimal because the piles would not form a perfect seal. If an average 1/4-inch gap remains between the individual piles and the rock contact, the cutoff efficiency would be only 28%. That is, 72% of the seepage flow occurring without the cutoff piles would still pass through the gaps in the pile wall. For these reasons, this option was rejected as ineffective.

The Bureau of Reclamation also examined backfilling the void beneath the dam with grout or concrete to stabilize its foundation. However, holes drilled through the dam in 1967 indicated the rockfill underlying the fir mattress (used as part of the fill material) is essentially free-draining. Backfilling or grouting the void space beneath the dam would reduce drainage, change flow paths, and possibly initiate failure of the underlying sand and gravel, the very situation the team is trying to avoid, and so it was rejected.

Historical American Engineering Record drawing (draft, 1995) showing the blow-out section of Elwha Dam. (Olympic National Park, Peter Mattson drawing)



SOURCES CROSS SECTION OF DAM BY MEAD AND SEASTONE CONSULTING ENGINEERS MADISON WISCONSIN JAN 21, 1915. PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM BY CH2M HILL, 1978

A third option that received serious consideration was the construction of a berm against the toe of the dam to stabilize the foundation of the structure. In this way, the upstream fill could be breached, and the dam notched down in a controlled fashion. When the dam was reconstructed in 1913, the downstream area was filled in first, and a stable, though pervious, condition was attained with the reservoir at elevation 118. It appears the upper 20 feet of the downstream fill has been eroded since the reconstruction due to spillway discharges. If this free-draining fill were to be replaced and increased sufficiently to provide an appropriate safety factor (for the higher reservoir level after the fir mattresses were breached), conditions would be stable. The upstream fill could be breached and monitored. However, several problems were identified, including (1) the berm would have to resist streamflows and possibly flood flows during notching of the dam, (2) the berm may have to extend above the existing sluiceways, so that they could not be used as low-level outlets, (3) a source of rockfill would be needed for berm construction, and (4) removal of the berm materials would be required following demolition of the dam. These unsolved problems eliminated this option.

Glines Canyon Dam. (Charles Scott photo)

A fourth alternative would have removed the concrete plugs in all four of the existing Elwha Dam sluiceways to create low-level outlets. Although this would partially drain the reservoir, the excavation of unstable fill might have required a steep cut slope to safely pass flows. A downstream stability berm would be required to prevent blowout of the foundation materials under the higher reservoir heads. This option presented several technical concerns with no apparent cost savings, and so was rejected.

Glines Canyon Dam

Previous studies assumed concrete demolition using conventional drill and blast techniques. A variety of alternative demolition methods was evaluated for the current studies, including diamond-wire sawcutting, stitch drilling, chemical splitting, hoe-ramming, high-pressure waterblasting, flame-cutting, and combinations of these methods. The diamond-wire sawcutting and boom-mounted hydraulic impact hammer (or hoe-ramming) methods of concrete demolition warranted further study. Diamond-wire sawcutting was used extensively to breach Waddell Dam, a multiple-arch concrete dam in Arizona. Bluebird Dam, a 58-foot-high concrete arch dam in Rocky Mountain National Park, was completely demolished using a boom-mounted hydraulic impact hammer.

Hoe-ramming would produce concrete rubble, which would be easier to remove if, as at Bluebird Dam, material was air-lifted. However, large cranes or cableways would be less expensive and more practical at Glines Canyon Dam. Larger cuts of smooth-faced blocks of concrete could be loaded on trucks by the cranes. This combination was found to be more cost-effective; hoe-ramming seem to offer no clear advantage over diamond-wire saw-cutting for the majority of the excavation at Glines Canyon Dam. Hoe-ramming may be used for final cleanup on the rock abutments.

Stream Diversion

The *Elwha Report* included an alternative of a diversion tunnel through the left abutment of Glines Canyon Dam, with an intake near the existing power tunnel intake and an outlet approximately 100 feet downstream of the power plant. Following construction of the diversion tunnel, reservoir levels would be lowered and streamflow would completely bypass the demolition area. The lake tap inlet would be lowered in 10-foot stages by controlled blasting as the reservoir was drawn down. A cofferdam constructed just upstream of the tunnel outlet would permit construction of a haul road to the base of the dam for removal of concrete rubble. The diversion tunnel and gate shaft would be plugged following removal of the dam. The estimated cost for the diversion tunnel and structure removal was $12.37 million (1992 dollars).

The EIS team believed significant risk and expense would be associated with the construction of a temporary diversion tunnel at Glines Canyon Dam (as with Elwha Dam). Based on experience at Theodore Roosevelt Dam, costs of constructing a tunnel at Glines Canyon Dam were probably underestimated in the *Elwha Report*. Since other streamflow diversion methods would be technically feasible at lower costs, the diversion tunnel alternative was eliminated from further consideration.

The *Elwha Report* also included an alternative of enlargement of the existing 5-foot-diameter sluiceway outlet in the arch dam section. Construction of the new outlet would require the underwater removal of the trash rack and installation of a large steel bulkhead on the upstream face of the dam. Reservoir releases would continue to be made through the power penstock until completion of the new outlet. Reservoir releases through the new outlet would be controlled to elevation 460 by a 117-inch-diameter fixed-cone valve. Below elevation 460, streamflow would pass through gated notches in the remaining portion of the dam in a progressive stepped approach. The estimated cost for the low-level outlet and structure removal was $8.44 million (1992 dollars). The *Draft Staff Report* briefly described a similar diversion alternative, requiring a new 7.5-foot-diameter outlet through the arch section with a 6-foot-diameter regulating valve for low-level releases, but structural analyses were not conducted to confirm its feasibility.

Although the EIS team believes this alternative would be technically feasible, the element of risk associated with underwater construction and the probable interference of debris and sediments at the upstream face of the dam on the bulkhead installation and operation of the outlet would be of concern. There seemed to be no clear advantage in construction costs for this alternative, and design costs would be higher for the necessary structural analyses.

The FERC *Draft Staff Report* and the *Elwha Report* briefly discussed a channel bypass alternative which would use the existing power intake and penstock for streamflow diversion. A small diversion embankment would divert flows at the upper end of the reservoir to a trapezoidal channel along the western edge of the reservoir for 8000 to 9000 feet. Numerous potential problems and very high construction costs were identified for this alternative, and no further studies were made.

Sediment Management

The EIS team considered many different methods to manage sediment. Approximately 9 million cubic yards of the 18 million cubic yards of sediment stored behind the dams is "fine" — composed of smaller-sized particles, mostly silt and some clay-sized sediment. The remainder is coarse, and consists of sand, gravel, cobbles and boulders. In the *Elwha Report*, nine different sediment management scenarios were examined for technical and economic feasibility. All use one or a combination of river erosion, mechanical removal, and/or stabilization. A short summary of each of these nine follows:

Scenarios 1 and 2 would hydraulically dredge or mechanically excavate both fine and coarse sediments. In scenario 1, the material would be disposed of on land; in scenario 2, in salt water. Both scenarios envisioned the use of trucks to haul the material to land disposal sites or to barge-loading facilities for ocean disposal. Preliminary cost estimates indicated scenario 1 at an estimated $200 million, scenario 2, approximately $300 million. Later work done as part of this planning process showed that coarse sediment would not be as problematic for fish as originally thought, and is in fact a resource, so it would not need to be dredged and removed. Also, slower removal of the dams would moderate the release of coarse sediment to minimize impacts from short-term flooding. Further work also showed that a pipeline to slurry sediment would be significantly less expensive than trucking dredged material, and would accomplish the same goal. Therefore, both alternatives 1 and 2 were eliminated from further study. Removing the coarse or delta material is also part of alternatives 8 and 9 in the *Elwha Report*. Since coarse sediment would not cause significant impacts for aquatic life, these alternatives were also eliminated.

Scenarios 3 and 4 used river erosion, wholly or in part, to remove sediments from behind the dams. Scenario 3 would let the river erode all sediment, fine and coarse, to the ocean. Scenario 4 would have used the river to erode fine sediment from Lake Mills downstream to Lake Aldwell, where some would settle. Coarse sediment would have been transported to Lake Aldwell in a pipeline. Although both are considered feasible, scenario 4 would have involved dredging Lake Aldwell to make room for Lake Mills sediments. Lake Aldwell would have been left in place indefinitely, causing passage mortality for fish and only partially restoring the ecosystem. Since the decision to fully restore the fisheries and ecosystem had already been made, this alternative was dropped from further study. Scenario 3, river erosion of all sediments, remains a viable option and is the proposed action in this environmental impact statement, although its analysis is much more rigorous.

Scenarios 5, 6, 7 all depend entirely or partly on the stabilization of fine and/or coarse sediments. Stabilization would leave most of the sediment in the reservoir area, and would attempt to keep it in place through revegetation or mechanical means. Subsequent work has shown it would be very difficult to stabilize fine material in the reservoir area, and storing it would cause a restricting of the natural floodplain width. Reservoir drawdown tests have indicated that fines erode quickly, and stabilizing them inside the natural 100-year floodplain would be impossible during flood flows over the long term. Outside the floodplain, rain would wash the fines into the river. Attempting to stabilize reservoir sediments in place would result in the periodic release of large suspended sediment loads into the river over many years — a condition that could reduce the chances of timely restoration of many fish stocks. Nor would stabilization by mechanical means permit restoration of the pre-dam landscapes. Deliberate stabilization of fines, and scenarios 5, 6 and 7 in the *Elwha Report*, have been rejected for these reasons.

Scenario 5 in the *Elwha Report* would have dredged material and placed it in the path of the river to erode naturally. A computer model using data from an 18-foot drawdown of Lake Mills shows it is more efficient to maximize the potential of the river to erode reservoir and delta sediments by holding water levels in the reservoir steady for a short period of time after each step in dam removal. This would redistribute sediments downstream, closer to the dam face, and increase the amount of sediment the river removes.

The EIS team also examined alternatives not in the *Elwha Report*. One would have mechanically removed fine sediment from Lake Aldwell, and used river erosion to remove all sediment from Lake Mills and coarse sediment from Lake Aldwell. This alternative was developed to decrease the duration of high sediment impacts while extending the duration of dam removal activities. However, fish biologists agreed the greatest impact would come from fines in Lake Mills and that any initiation of work on Lake Aldwell would make the river turbid. Therefore, making a special effort to dredge fines from Lake Aldwell first would not be helpful for fish.

Removal of Glines Canyon Dam first with Elwha Dam in place was considered but rejected because Lake Aldwell would not trap all sediments eroded downstream from Lake Mills; water quality mitigation would still be necessary. Even with Elwha Dam in place, most of the silt and clay eroded from Lake Mills would pass through Lake Aldwell since the sediment trap efficiency of Lake Aldwell is less than that of Lake Mills (Hosey and Associates 1988).

Another alternative based on a similar idea would have dredged fines from Lake Mills and dumped them into the river below Glines Canyon Dam. This would have allowed a greater measure of control in determining when and to what degree fines would enter the water column. However, the degree of suspended sediment would still have been extremely high — lethal to fish and conferring no advantage in the design of water quality mitigation measures. Both these alternatives were eliminated from further consideration.

Table 12. *Impact Summary Chart*

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
SEDIMENT MANAGEMENT			
Reservoir areas	Reservoirs continue to trap sediments, (now 13.8 million cubic yards in Lake Mills and 3.9 million cubic yards in Lake Aldwell).	1.2-2.6 million cubic yards of coarse, and 4.8-5.6 million cubic yards of fine sediment would erode from reservoirs.	1.2-2.6 million cubic yards of coarse, and 1.2-1.4 million cubic yards of fine sediment would erode from reservoirs; remainder slurried to strait.
Downstream channel	Reduced amounts of coarse-grained sediments (sand-size and larger) downstream of reservoirs, less meandering of river, armoring of river channel.	Fine-grained sediment and sand would move rapidly downstream, approaching background levels in 2 to 6 years; coarse sediments deposit and aggrade riverbed; more meandering and streambank erosion would be a beneficial impact.	Same as proposed action except less fine sediment eroding downstream (25% of total).
Delta, beaches and Ediz Hook	Continued beach erosion, recession of delta and erosion of western edge of Ediz Hook and Angeles Point.	Re-establish sediment supply, rebuilding of beaches and delta within 3 years; begin to reverse erosion of Ediz Hook within 5-10 years.	Same as proposed action.
FLOODING			
Increases in water surface elevation, aggradation	Degradation of riverbed has lowered flood stage - a beneficial impact to property owners and adverse impact to the river's ecosystem; houses (except behind federal levee) and private wells along river flood at less than 100 year frequency flood event, a potential major adverse impact.	Riverbed aggradation would cause increases in river stage of up to 4 feet; mandatory mitigation on federal levee and for municipal and industrial water wells would provide current level of flood protection; without recommended mitigation other areas may experience major impacts due to more frequent flooding (not significantly different than existing conditions); short-term flooding impacts less than long-term impacts.	Same as proposed action - dredging of fine sediments would have no additional impacts on flooding.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
SURFACE WATER			
Short-term (during dam removal) critical indicators			
Total suspended solids in river (peak concentrations)	Dams have reduced peak TSS to less than 1,500 parts per million. Moderate beneficial impact to water quality.	28,000 to 51,000 parts per million - major adverse impact for 1 to 3 day periods.	1,400 to 13,000 parts per million - major adverse impact for 1 to 3 day periods.
Total iron	Dams may have slightly reduced to peaks of 20 to 2,300 micrograms per liter. Negligible or minor impact to water quality.	30,000 to 50,000 micrograms per liter maximum for 1-3 day periods - major adverse impact.	5,000 to 15,000 micrograms per liter maximum for 1-3 day periods - moderate to major adverse impact.
Total manganese	Dams may have slightly reduced to peaks of from 4 to 210 micrograms per liter. Negligible or minor impact to water quality.	500 to 10,000 micrograms per liter maximum for 1-3 day periods - possible major adverse impact to water quality.	50 to 1,500 micrograms per liter maximum for 1-3 day periods - moderate to major adverse impact.
Turbidity	Dams have reduced peak turbidity to 800 NTUs; moderate beneficial impact to water quality.	2,000 to 25,000 NTUs maximum for 1-3 day periods - major adverse impact .	1,000 to 10,000 NTUs maximum for 1-3 day periods - major adverse impact.
pH during dam removal	6.7 to 10.0 now; negligible impact.	5 to 9 - minor change.	6 to 9.5 - minor change.
Temperature (Celcius) during dam removal	Reservoirs have resulted in increased peak temperatures to 19° C. Major adverse impact to water quality/aquatic life.	15° C to 19° C - minor to major beneficial impact.	15° C to 19° C - minor to major beneficial impact.
Dissolved oxygen during dam removal	95 to 110%; negligibile or minor impact	90 to 100% - minor change.	95 to 105% - minor change.
Long-term (from 1 year after dam removal) critical water quality indicators			
Total suspended solids in river	Dams have reduced TSS concentration to less than 1,500 ppm; moderate beneficial impact to water quality.	Average 69 parts per million within 2 years after dam removal - moderate adverse impact.	Same as proposed action.
Turbidity	Dams have reduced peak turbidity to 800 NTUs; moderate beneficial impact to water quality.	1 to 1000 NTUs within 2 years following dam removal - moderate adverse impact.	1 to 1000 NTUs within 1 year following dam removal - moderate adverse impact.
Dissolved iron	Dams may have reduced peak concentrations to 2,300 micrograms per liter; minor benefiicial impact to water quality.	10 to 5,000 micrograms per liter within 2 years - minor adverse impact to water quality.	10 to 5,000 micrograms per liter within 1 year - minor adverse impact.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Dissolved manganese	Dams may have reduced peak concentrations to 210 micrograms per liter; minor beneficial impact to water quality.	10 to 700 micrograms per liter within 2 years following dam removal - minor adverse impact to water quality.	10 to 700 micrograms per liter within 1 year following dam removal - minor adverse impact to water quality.
pH	6.7 to 10.0; negligible to minor impact.	6.5 to 8.5 - minor beneficial impact.	Same as proposed action.
Temperature (Celcius)	Reservoirs have increased peak temperatures to 19° C; major adverse impact to water quality and aquatic life.	15° C to 17° C - major beneficial impact.	Same as proposed action.
Dissolved oxygen	95 to 110%; negligible or minor impact.	95 to 110% - no change over existing conditions.	Same as proposed action.
SURFACE WATER USERS			
Daishowa and Rayonier mills	Existing treatment prevents adverse impacts.	Addition of infiltration gallery and pre-treatment will prevent adverse impacts in short and long-term. No impact.	Same as proposed action.
Washington Department of Fish and Wildlife fish rearing channel	No treatment now. Some pulses of turbidity during high flow events.	Facility would close during removal; moderate 1-2 year adverse impact. Iinfiltration gallery would minimize adverse impacts in long-term .	Same as proposed action.
Lower Elwha Klallam Tribal Fish Hatchery	Infiltration gallery/groundwater wells filter surface water now.	Enlarging infiltration gallery, drilling new wells to enlarge capacity would prevent adverse impacts in short and long-term. No Impact.	Same as proposed action.
GROUNDWATER			
Turbidity	High suspended sediment levels increase turbidity in some wells (Dry Creek Water Association, and wells hydraulically connected to river) now.	Suspended sediment would infiltrate aquifers and well screens of some wells and cause major impacts from turbidity in well water.	Suspended sediment would infiltrate well screens of some wells and cause moderate impacts from turbidity in well water.
Suspended sediments	Minor impacts to well yield now.	May settle in spaces between granules in aquifer and decrease yields. Moderate adverse impact.	May settle in spaces between granules in aquifer and decrease yields. Minor to moderate adverse impact.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Dissolved iron	Average below 0.3 milligram per liter drinking water standard in Pt. Angeles Ranney collector; max concentration 1.0 milligram per liter.	Dissolved iron could infiltrate well screens and cause mineral staining of fixtures and clothing, metallic tasting drinking water. Probability of impact low, minor to moderate impact if it occurs.	Dissolved iron could infiltrate well screens and cause mineral staining of fixtures and clothing, metallic tasting drinking water. Minor impact if it occurs.
Dissolved manganese	No water samples tested above state standards.	Dissolved manganese could infiltrate well screens and cause mineral staining of fixtures and clothing. Probability of impact low, minor to moderate impact if it occurs.	Dissolved manganese could infiltrate well screens and cause mineral staining of fixtures and clothing. Minor impact if it occurs.
Coarse sediment/ aggradation	Riverbed is nearly devoid of coarse sediment where wells are located; wells are built close to river's edge.	Aggradation and increases in surface water elevation would lead to overtopping and contamination of wells close to river's edge or in floodplain. Major long-term adverse impact.	Same as proposed action.
Water table levels -- Lake Aldwell area	Lake Aldwell supports an artificially high groundwater level in east end of Indian Creek valley.	Two wells would experience decrease or loss of yield. Major long-term adverse impact.	Same as proposed action.
Water table levels -- lower reach area	Groundwater elevation in lower valley is artificially low because of degradation of riverbed.	Aggradation would increase groundwater levels and make septic systems unusable-moderate impact to those users in the long term.	Same as proposed action.
GROUNDWATER USERS			
City of Port Angeles municipal supply	Water is filtered and chlorinated, some high turbidity and iron levels.	A second Ranney collector, treatment and flood protection for the existing Ranney collector would prevent adverse impacts to water quality and yield. No Impact.	Same as proposed action.
Dry Creek Water Association	Some high turbidity levels now.	Connecting to Port Angeles Ranney Collector would prevent adverse impacts to water quality. No Impact.	Same as proposed action.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Elwha Place Homeowners' Association	No impacts now.	Increases in turbidity and iron or manganese could have minor to moderate impacts on well water quality; increased surface water elevation could flood and overtop wells; major impact if it occurs. Recommended mitigation would reduce impacts to negligible.	Increases in turbidity and iron or manganese could have minor impacts on well water quality; increased surface water elevation could flood and overtop wells; major impact if it occurs. Recommended mitigation would reduce impacts to negligible.
Lower Elwha Klallam Reservation residents	Groundwater elevation low; septic systems installed and usuable.	Increased groundwater elevation would render 10 septic systems unusable. Moderate impact in long-term.	Same as proposed action.
Individual wells in lower valley and upstream of Highway 101 bridge	Wells built close to river's edge; some increases in turbidity now.	Increases in turbidity and iron or manganese could have minor to moderate impacts on well water quality; increased surface water elevation could flood and overtop wells; major impact if it occurs. Recommended mitigation would reduce impacts to negligible.	Increases in turbidity and iron or manganese could have minor impacts on well water quality; increased surface water elevation could flood and overtop wells; major impact if it occurs. Recommended mitigation would reduce impacts to negligible.
Individual wells upstream of Lake Aldwell	Groundwater high because of Lake Aldwell.	Groundwater level and yield would drop or stop altogether. Major, long-term adverse impact. Recommended mitigation would reduce impact to negligible.	Same as proposed action.
Unidentified users	Unknown impacts.	May experience short-term increases in turbidity, iron and manganese, water level differences or changes in yield. Impact intensity unknown. Mitigation would reduce impact to negligible.	Same as proposed action.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
NATIVE RESIDENT AND ANADROMOUS FISHERIES			
Long-term restoration	No chance of restoring native anadromous fish in the Elwha River; genetic integrity of the existing native stocks deteriorates due to continued use of hatchery stocks; existing stocks in the lower river unsupported by artificial propagation would likely decline to extinction.	All Elwha River anadromous fish stock except sockeye salmon fully restored within 20 years. Hatchery support, outplanting, harvest management, and optimal timing of dam removal could halve restoration time.	The long-term beneficial impacts would be the same as the proposed action except full restoration of native fish stock would occur in slightly less time.
Species-specific restoration potential	No restoration.	The Elwha River could eventually produce an estimated 31,000 chinook salmon, 35,000 coho salmon, 274,000 pink salmon, 36,000 chum salmon, 10,000 steelhead, and 6,500 sockeye salmon per year.	Same as proposed action.
Short-term impacts	Existing conditions, i.e. poor quality habitat, hatchery propagation and crowded spawning conditions would not change.	The release of fine sediment during and following dam removal would cause mortalities, physiological stress, or displacement of fish in the river for up to four years, and cause returning adults to avoid migrating up the river. Hatchery support, outplanting, harvest management, and optimal timing of dam removal would help protect fish during this period.	The short-term adverse impacts of fine sediment on trout and salmon and their habitat would be reduced by removing as much as 75% of the fine sediments with a dredge and slurry pipeline in combination with other measures. Direct fish losses and the risk of straying adults would be reduced.
Chinook salmon	Same as above.	Direct fish loss caused by extreme sediment. Hatchery support and outplanting would replace fish lost to high sediment levels and begin to reestablish stock in the middle and upper Elwha River.	Same as proposed action except the direct fish loss caused by high sediment levels would be less.
Coho salmon	Same as above.	Same as for Chinook Salmon.	Same as proposed action except direct fish losses would be less.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Pink salmon	Same as above.	Direct loss, if pinks present, caused by extreme sediment levels. Hatchery support and outplanting of Dungeness stock would begin to reestablish pink salmon in the Elwha River.	Same as proposed action except, if pinks present, the direct fish loss caused by high sediment levels would be less.
Chum salmon	Same as above.	Direct fish loss caused by extreme sediment levels. Hatchery support and outplanting would reduce adult fish loss and replace young fish lost caused by high sediment levels. Begin to reestablish stock in the middle and upper Elwha River.	Same as proposed action except the direct fish loss caused by high sediment levels would be less.
Sockeye salmon	Same as above.	No direct fish loss caused by extreme sediment levels. There would be no hatchery or outplanting effects. The existing Lake Sutherland kokanee population may eventually reestablish a native sockeye run.	Same as the proposed action.
Steelhead	Same as above.	Same as for Chum Salmon.	Same as proposed action except direct fish losses would be less.
Sea-run cutthroat & char	Same as above.	Direct fish loss caused by extreme sediment levels. There would be no hatchery or outplanting effects. Natural recolonization by remnant stocks would eventually reestablish anadromous populations.	Same as proposed action except the direct fish loss caused by high sediment levels would be less.
VEGETATION			
Restored communities	562 acres of vegetation, much of it important, low elevation riparian communities, would remain lost.	562 acres of vegetated lands would recover: 514 of forested lands and 48 of other vegetation.	Same as proposed action except for minor impacts of constructing the slurry pipeline.
Riparian communities	5.3 linear miles inundated.	5.3 miles returned.	Same as proposed action.
Wetlands	43 acres of vegetated and 122 acres of unvegetated, riverine wetlands would remain lost; these losses have likely reduced biodiversity in the area.	Portion of 43 acres may be lost; 48 acres of vegetated and 122 acres of unvegetated wetlands would be restored.	Same as proposed action.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
WILDLIFE			
Terrestrial habitat including elk and other mammals, trumpeter swans and other birds	715 acres of natural wildlife habitat would remain lost. Without anadromous fish runs, critical to the wildlife community, natural biodiversity of the area would remain compromised.	Restoration of habitat and fish runs would be a major beneficial impact to most species including elk. Species dependent on the reservoirs, including trumpeter swans, would lose habitat, but regional impacts would be minor.	Same as proposed action except for minor wildlife disturbances along the lower river while constructing the slurry pipeline.
SPECIES OF SPECIAL CONCERN			
Federally listed species: bald eagle, northern spotted owl, marbled murrelet, Steller sea lion, and peregrine falcon	Natural populations of salmon would remain unavailable to foraging bald eagles. Up to 514 acres of potential habitat for spotted owls and murrelets would remain unavailable. Sea lions and falcons would sustain continued minor impacts.	Bald eagles, spotted owls, and murrelets would be adversely impacted in the short term (2 to 5 years) by noise, turbidity, but return of salmon as prey and upland forest as habitat would have a major beneficial impact in the long term. Sea lions and falcons would experience minor beneficial and no impacts, respectively.	All impacts would be the same as the proposed action except: spotted owls and murrelets may be impacted from the noise of dredging activities. Impacts to foraging bald eagles would be slightly less, because turbidity and impact on fish as prey would be less.
Candidates for federal listing including Pacific fisher, harlequin duck, northern red-legged frog, and bull trout	Over 5 linear miles of riparian and riverine habitat would remain unavailable for Pacific fishers and harlequin ducks.	Harlequin ducks and bull trout would sustain short-term, minor impacts. All species would sustain major beneficial impacts in the long term.	Impacts to harlequin ducks and bull trout would be slightly less due to less turbidity in the river.
Species or stocks considered for federal listing: coho, chum and chinook salmon, steelhead, and sea-run cutthroat trout	Habitat for these species would remain unavailable, possibly contributing to the listing of these stocks under the Endangered Species Act.	All species would be adversely impacted in the short term, but over the long-term, restoration would offset some cumulative impacts occurring elsewhere in the region.	Same as proposed action.
Candidates for state listing including pileated woodpecker, Van Dyke's salamander, and Vaux's swift	Forest and riparian habitat for these species would remain inundated.	All species would sustain major beneficial impacts in the long term.	Same as proposed action.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
LIVING MARINE RESOURCES			
Nearshore marine communities	Existing marine communities would remain, the delta and estuary would be undersized, and clam populations would be lower than under pre-dam conditions.	Moderate adverse impacts would occur to local marine communities from silt and clay transported by the river. A major change would occur, from transport of sand and gravel, in the substrate and biological community at the river mouth and to the east. However, future conditions would approximate pre-dam conditions.	Same as proposed action.
AIR QUALITY			
Air quality	Air quality is presently high quality and would stay this way. The projects do not affect air quality.	Elwha Dam demolition would result in 105.3 tons of particulates and Glines Canyon Dam demolition, 25.2 tons over the 18-month to 2-year dam removal period. Impact to local area would be minor, except from use of one-half mile of unpaved haul road, which would have moderate adverse impacts to residents without mitigation. Sprinkling with water (required) would reduce impact to minor.	Same as the proposed action except trenching for pipeline may add minor amounts of PM_{10} and TSP (particulates).
NOISE			
Continuous noise	Noise from project negligible impact on residents or wildlife.	Residents of approximately 20 homes closest to (within 0.6 mile) the Elwha Dam would experience short-term minor increases in noise levels to as high as a typical office environment (about 58 decibels) under poor atmospheric conditions. Residents further away would be unaware of day-to-day construction noise.	Noise levels for this alternative would be quantitatively indistinguishable from the proposed action. The trenching operations required for pipeline laying and the pumping stations required to pump the slurried fines would result in minor noise that could have minor, short-term impacts on residents in the immediate vicinity.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Acute noise	No blasting or other sudden loud noise exists in the vicinity.	Residents beyond 1.2 miles of blasting sites would not be expected to hear blasting noise. The 20 residents within 0.6 miles of the Elwha Dam would periodically experience noise similar to moderate thunder. Minor short-term impact to these residents.	Same as proposed action.
CULTURAL RESOURCES			
Construction related impacts	No effects to properties listed on the National Register of Historic Places (NRHP); continued major adverse impacts to cultural resources inundated by the reservoirs; no effects to cultural resources in or near the floodplain.	Major adverse effect to hydroelectric projects. Mitigation through HABS/HAER inventory, documentation, and leaving some structures in place at Glines reduces impacts to minor. Permanent, major beneficial impacts to cultural resources important to the tribe by making previously inundated resources accessible. Minor to negligible impacts, with mitigation, to cultural resources and cultural landscapes in the immediate vicinity of damsites.	Same as proposed action except that trenching of pipeline could affect some cultural resources; with mitigation, impacts would be minor.
Offsite disposal of dam rubble	No effects to cultural resources.	Minor impacts, with mitigation.	Same as proposed action.
Increased flooding and erosion	No effects to cultural resources.	Minor impacts, with mitigation, to sites potentially affected by increased flooding and erosion.	Same as proposed action.
Construction of access roads and staging areas	No effects to cultural resources.	Moderate, short-term impacts to Elwha Ranger Station Historic District, Altaire and Elwha campgrounds kitchen shelters, known and potential landscapes, culturally sensitive areas, known and unknown archeological sites if roads built near or these areas are used for access/staging of equipment. With mitigation, impact minor.	Same as proposed action.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
SOCIOECONOMICS			
County economic base	Ten employees would continue to be required for the operation of the hydroelectric projects. Travel and tourism creates about 2,000 jobs and $21.3 million now. Tax receipts from tourism/travel estimated at $1.4 million.	Major long-term beneficial impacts would occur to the county's economic base. Over the 10-year pre-construction, construction and restoration period, an additional 1150-1240 jobs, $60-65 million in business activity, and $32-34 million in personal income would be generated in Clallam County. After restoration completed, 446 annual jobs, $4.6 million in annual payroll in the recreation/ tourism sector, and an annual increase in local sales taxes of $296,000 would be generated. County property tax on projects eliminated ($230,000 per year). Local share of state sales tax would increase by $296,900 per year after project completion.	Higher capital costs of pipeline would incrementally increase net cost of project, but not significantly. Major long-term beneficial impacts to the county's economic base would still occur under this alternative.
Infrastructure, services and utilities	Clallam County 1993 operating budget ($14.8 million); $4.3 million in property taxes collected, of this, $230,000 was from hydroelectric projects. A total of $2.1 million generated from sales tax payments to county general fund in 1993. Annual maintenance costs of $100,000 for Ediz Hook would continue. Housing stock adequate to meet future demand.	County would not collect $230,000 in annual property taxes from the projects. Annual maintenance costs for Ediz Hook reduced by $28,000 per year. Housing and public infrastructure would be adequate to meet construction worker and river-restoration related population demand.	Same as proposed action.
Estimated project cost	Not applicable	$111.1 million	$127.4 million

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Impacts to Daishowa America Mill and electric power consumer	Estimated 1996 cost of power production from the dams, without any improvement expenses is 12.29 mills; real priority firm for purchased power is 26.7 mills; real rate expected to decline to 23 mills by 2001. Estimated annual real energy cost for replacement power in 2010 is $2.1 million. Dams would require $8.7 million in repair costs; annual operational costs of the dams would continue at $2.1 million.	Daishowa's power aquisition costs would start at 26.7 mills, and would decline to 23 mills by 2001. Estimated annual real energy cost for replacement power in 2010 is $4.0 million. Negligible impacts to overall electric rates. Dam repair costs of $8.7 million not necessary. Power cost to the mill increases to $4 million annually. $440,000 in payments to local energy utility not collected.	Same as proposed action.
Fisheries and fish processing	Continued major adverse impact--total annual net business benefits from Elwha fishery currently estimated at $840,000.	Major beneficial impact--total annual net business benefits from Elwha fishery would reach $3.5 million.	Same as proposed action.
Recreation and tourism	Travel/tourism expenditures (1993) in Clallam Co. $116.9 million. Related payroll income $18.8 million.	An increase of 734,000 annual visitor nights in Clallam County is expected with river restoration, generating business expenditures of $28.5 million annually. Related payroll income increased by $4.6 million annually.	Same as proposed action.
Social values	Dams considered an important source of local pride to some residents. County and region would continue to experience economic trends from resource based to tourism based economy. No sharp changes in social structure anticipated.	Minor impact to social structure.	Same as proposed action.
Lower Elwha Klallam Tribe	Major long-term adverse impact to level of tribe's poverty, employment, income, health, and social structure.	Major beneficial impact to level of tribe's poverty, employment, income, health, and social structure.	Same as proposed action.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Nonmarket values	No change or impacts expected.	Major beneficial impacts; restoration expected to generate $3.5 billion annually for 10 years.	Same as proposed action.
Net economic value of project	Daishowa America pays $2.1 million/yr. for 172 gigawatt hours. Major impact to commercial, recreational fishery sectors continues. Overall, recreation and tourism continue slow growth trend.	Major beneficial impact; benefits from increase recreation and tourism would reach $133 million over 100 years of project life. The $3.5 million per year of net economic benefits after fish stocks were restored would reach $35 million over project life.	Same as proposed action.
PUBLIC HEALTH AND SAFETY			
Earthquakes	Glines Canyon Dam considered safe for currently identified maximum credible earthquake, and probable maximum flood; safety of Elwha Dam is unknown. If MCE is modified, may need to reanalyze and modify structures.	Dam removal would remove danger from flooding caused by maximum credible earthquake; would eliminate need to correct structural deficiencies in the future.	Same as proposed action.
Dam safety	Both dams considered safe during currently identified probable maximum flood and maximum credible earthquakes (MCE).	Safety precautions built into dam remoal designs, no safety risks anticipated during deconstruction; dam removal would eliminate potential of dam failure.	Same as proposed action.
Hazardous materials	Asbestos, lead based paint and PCBs would continue to pose a threat of further contamination. Hydrocarbons would require clean-up.	Remediation or removal of materials (petroleum contaminated soils, underground storage tanks, asbestos, and various chemical stores) prior to dam removal would reduce the threat of further contamination.	Same as proposed action.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
TRANSPORTATION			
Levels of service for peak weekday hours during year 2000 at 13 intersections between damsites and disposal area	Levels of service are very good (LOS A) for most intersections. They are acceptable (LOS B) at the intersection of Old Olympic Highway and Sequim-Dungeness Road and (LOS C) at the intersection of US 101 and Highway 112, and poor (i.e. long delays and poor traffic flow-LOS F or LOS *) for the intersection of Marine Drive and Highway 117.	No changes to levels of service would be expected from the addition of project-related traffic.	Same as proposed action.
Levels of service for peak weekend hours during year 2000 at 13 intersections between damsites and disposal area	Same as weekday, except traffic flow is very good (LOS A) at the intersection of US 101 and Highway 112, and acceptable (LOS C) at Marine Drive and Highway 117.	No changes to levels of service would be expected from the addition of project-related traffic.	Same as proposed action.
Levels of service for peak weekday hours during year 2005 at 13 intersections between damsites and disposal area	Same as for year 2000 weekday, except the intersection of US 101 and Highway 112 is now poor (LOS F), and LOS at US 101 and Old Olympic Highway has declined from A to B.	No changes to levels of service would be expected from the addition of project-related traffic.	Same as proposed action.
Levels of service for peak weekend hours during year 2005 at 13 intersections between damsites and disposal area	All intersections except those listed below are operating well (LOS A). Marine Drive and Highway 117 is at LOS C, US 101 and Highway 112 is at B; US 101 and Old Olympic Highway is at D (still considered acceptable); and Old Olympic Highway and Sequim-Dungeness Road is at LOS B.	No changes to levels of service would be expected from the addition of project-related traffic except LOS at US 101 and Highway 112 would decline from B to C.	Same as proposed action.
INDIAN TRUST RESOURCES			
Federal trust responsibility to protect treaty fishing rights (up to one-half harvestable fish)	Dams have blocked access to, inundated and degraded fish habitat with major adverse impact to harvestable fish; access to usual and accustomed fishing places is blocked.	Permanent restoration of anadromous fisheries and access to usual and accustomed fishing places. Major, beneficial, long-term impact.	Same as proposed action except that fish restoration and access to usual and accustomed fishing places may occur sooner.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
TRANSPORTATION			
Levels of service for peak weekday hours during year 2000 at 13 intersections between damsites and disposal area	Levels of service are very good (LOS A) for most intersections. They are acceptable (LOS B) at the intersection of Old Olympic Highway and Sequim-Dungeness Road and (LOS C) at the intersection of US 101 and Highway 112, and poor (i.e. long delays and poor traffic flow-LOS F or LOS *) for the intersection of Marine Drive and Highway 117.	No changes to levels of service would be expected from the addition of project-related traffic.	Same as proposed action.
Levels of service for peak weekend hours during year 2000 at 13 intersections between damsites and disposal area	Same as weekday, except traffic flow is very good (LOS A) at the intersection of US 101 and Highway 112, and acceptable (LOS C) at Marine Drive and Highway 117.	No changes to levels of service would be expected from the addition of project-related traffic.	Same as proposed action.
Levels of service for peak weekday hours during year 2005 at 13 intersections between damsites and disposal area	Same as for year 2000 weekday, except the intersection of US 101 and Highway 112 is now poor (LOS F), and LOS at US 101 and Old Olympic Highway has declined from A to B.	No changes to levels of service would be expected from the addition of project-related traffic.	Same as proposed action.
Levels of service for peak weekend hours during year 2005 at 13 intersections between damsites and disposal area	All intersections except those listed below are operating well (LOS A). Marine Drive and Highway 117 is at LOS C, US 101 and Highway 112 is at B; US 101 and Old Olympic Highway is at D (still considered acceptable); and Old Olympic Highway and Sequim-Dungeness Road is at LOS B.	No changes to levels of service would be expected from the addition of project-related traffic except LOS at US 101 and Highway 112 would decline from B to C.	Same as proposed action.
INDIAN TRUST RESOURCES			
Federal trust responsibility to protect treaty fishing rights (up to one-half harvestable fish)	Dams have blocked access to, inundated and degraded fish habitat with major adverse impact to harvestable fish; access to usual and accustomed fishing places is blocked.	Permanent restoration of anadromous fisheries and access to usual and accustomed fishing places. Major, beneficial, long-term impact.	Same as proposed action except that fish restoration and access to usual and accustomed fishing places may occur sooner.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
Federal trust responsibility to protect shellfish harvesting rights (to take up to one-half of non staked or cultivated bed shellfish)	Degraded shellfish habitat in estuary and nearshore marine areas, near elimination of sandy substrate has caused decline in hardshell clam populations; impact unquantified, but considered major, adverse.	Restoring sediment transport would re-establish sandy substrate, larger and more complex estuary for shellfish. Major, beneficial, long-term impact.	Same as proposed action.
Federal trust responsibility to protect right to hunt on open and unclaimed lands	Inundated wildlife habitat,and loss of salmon as prey has had a major, unquantified adverse impact on wildlife	Restoration of 562 acres of land now inundated to natural vegetation, and of salmon throughout river would have major, long-term, beneficial impact to wildife.	Same as proposed action
Protection of primary purposes of Lower Elwha Klallam Reservation	Risk of flooding from Elwha Dam failure unknown but unacceptable to tribe. Impact should failure occur major and adverse. Near elimination of sediment beyond dams has contributed to erosion of tribal beaches. Impact unquantified, but considered major and adverse.	Dam removal would eliminate risk of flooding; restoring sediment transport would rebuild beach. Both major, permanent beneficial impacts.	Same as proposed action.
RECREATION			
Recreation facilities, including reservoirs	No change, lake oriented -- incongrous with pristine nature of Elwha River watershed.	Permanent loss of flatwater boating and fishing opportunities - other lakes available in area, so impacts considered moderate.; significant permananent increase in sport and marine fishing for anadromous salmon and trout; river oriented with an increase of 5.3 miles of river.	Same as proposed action except that dredge and slurry operation could disrupt river recreational activities.

IMPACT TOPIC	NO ACTION	RIVER EROSION (Proposed Action)	DREDGE AND SLURRY
AESTHETICS			
Short-term impacts	No change in visual features. Major impacts associated with damming the river in a naturally appearing landscape would remain.	Major short-term impact during construction and for 2-3 years after dam removal until vegetation begins to recover.	Same as proposed action except that pipeline would have a moderate impact on visual quality depending on route selected.
Long-term restoration	No change in visual features. Major impacts associated with damming the river in a naturally appearing landscape would remain.	Major beneficial impacts to aesthetics overall as area is restored to natural conditions and blend with surrounding landscape.	Same as proposed action.

Affected Environment

Previous page: Cedar trees in the Elwha valley, Washington, no date. (Clallam County Historical Society)

Lake Mills area after logging and before inundation, no date. (Daishowa/James River Company photo)

Affected Environment

Fluvial Processes and Sediment Transport

The Elwha River is 45 miles long, has 100 miles of tributary streams, and drains 321 square miles of the Olympic Peninsula (figure 7). Eighty-three percent of the drainage lies within Olympic National Park, comprising approximately 20% of the total park area. This portion of the river is protected from timber harvest, agriculture, and other land-use disturbances. The basin is approximately 10 miles wide in an east-west direction and 35 miles long. The river flows in a northerly direction into the Strait of Juan de Fuca, entering the strait 5 miles west of Port Angeles, a timber, tourism and shipping community of approximately 17,000 people. The Elwha is the fourth largest river by drainage area among the major Olympic Peninsula coastal and strait streams, with a watershed area smaller than those of the Quillayute, Queets, and Quinault rivers.

For the purposes of this environmental impact statement, the upper reach of the river is defined as upstream of Glines Canyon Dam; the middle reach, between the two dams; and the lower reach, below Elwha Dam (see figure 8).

The Elwha River has 15 tributaries greater than 4 miles in length (table 13). Most of these tributaries have extremely steep gradients. Two of the tributaries, Boulder Creek and Cat Creek, drain into Lake Mills. Four other streams are located along the middle reach: Indian Creek drains Lake Sutherland; Little River is a larger tributary that drains a watershed highly disturbed by logging; and Hughes and Griff creeks are very steep, originating at approximately 4,000 feet elevation.

Falls on Wolf Creek, near Lake Aldwell. (Curtis Miller photo)

Sediments in the Elwha River drainage basin are dominated by glacial deposits and recent alluvium. These sediments range in size from clay to boulders and provide much of the material available for transport by the Elwha River and its tributaries. Upstream from Lake Mills, the riverbed material consists of sand, gravel, cobbles, boulders, and, in some places, bedrock outcrops. In the vicinity of Lake Mills, the river is cut into at least 600 feet of sediments that were deposited in a glacial lake impounded by the Vashon ice sheet. A set of eroding cliffs comprised of glacial deposits on the west side of Lake Mills supports the presence of glacial Lake Elwha during the Vashon glaciation, 13,000 to 20,000 years ago. The lower 3.5 miles of the Elwha River is cut into a thick deposit of erodible, unconsolidated glacial outwash and till deposited by the same ice sheet.

River alluvium deposited since the retreat of the glacier typically consists of sandy gravel, cobbles, and boulders. Sediment eroded

Figure 7. *Elwha River System*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20056B

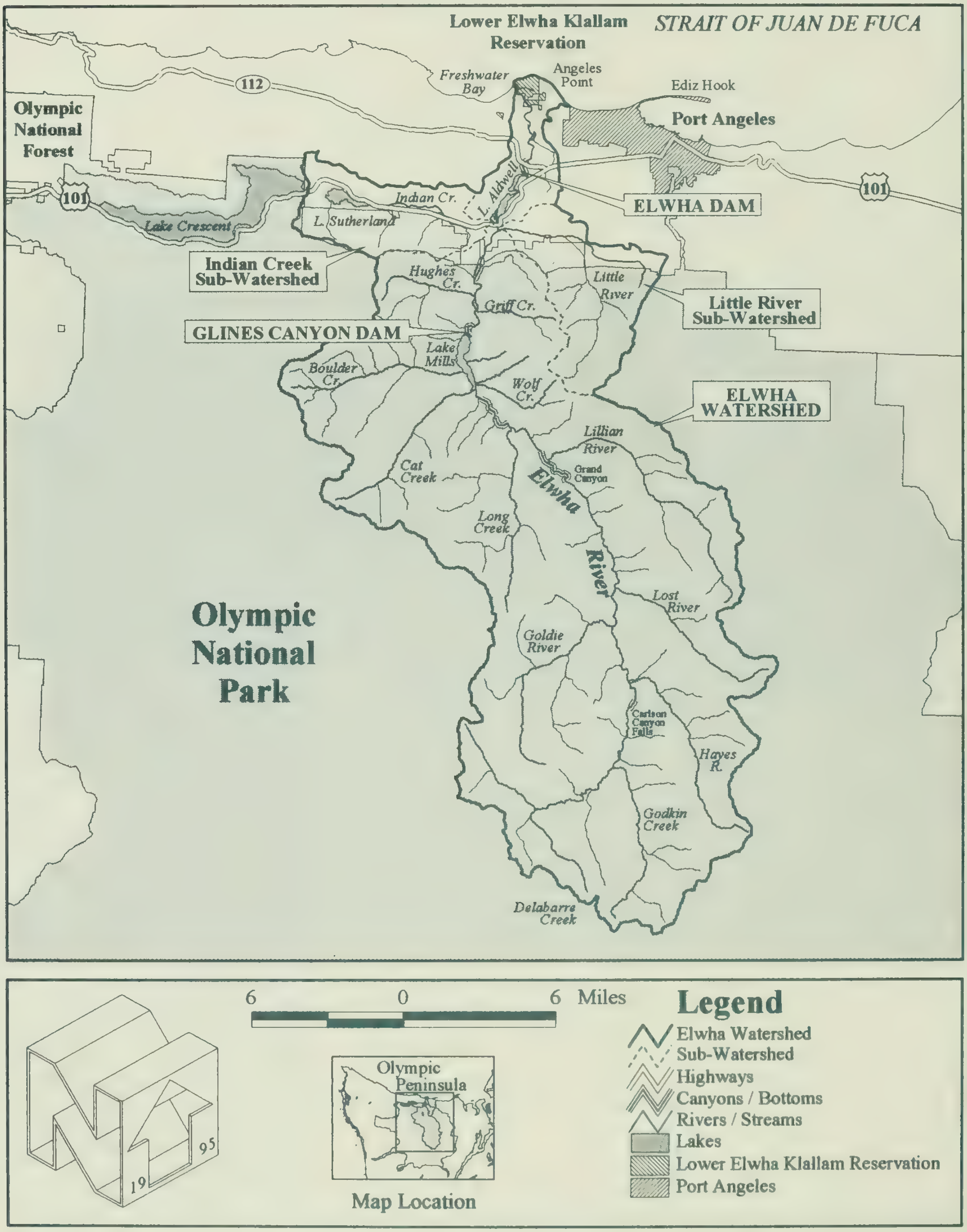


Figure 8. *Elwha River Reaches*

Olympic National Park

United States Department of the Interior - National Park Service

DSC - December 1995 - 149 - 20068

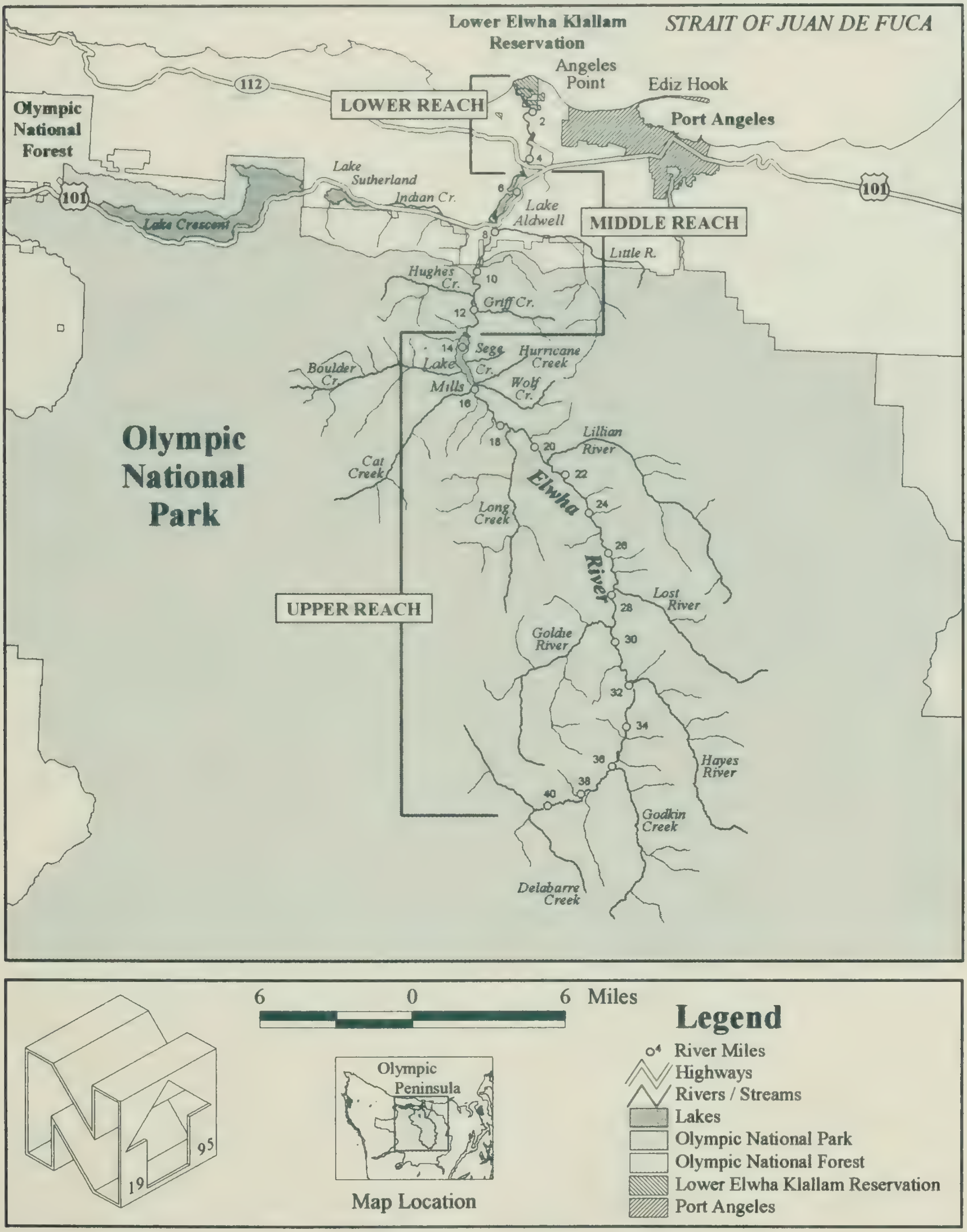


Table 13. *Major Elwha River Tributaries*

	LOCATION OF MOUTH (river mile)	TRIBUTARY LENGTH (miles)
Indian Creek	7.5	5.7
Little River	7.8	7.5
Hughes Creek	11.3	4.6
Griff Creek	11.4	4.1
Boulder Creek	15.1	7.6
Wolf Creek	15.8	4.0
Cat Creek	15.9	6.7
Long Creek	18.5	8.0
Lillian River	20.9	11.1
Lost River	27.7	7.7
Goldie River	29.4	8.6
Hayes River	31.9	9.0
Godkin Creek	36.1	7.2
Buckinghorse Creek	37.5	4.1
Delabarre Creek	40.4	4.3

SOURCE: Williams et al., 1975.

from the valley walls is transported by the Elwha River and tributaries. Considerable amounts of recent alluvium are stored along the river channel, particularly in the wide terraces outside the floodplain that make up the bottoms and river mouth.

River morphology

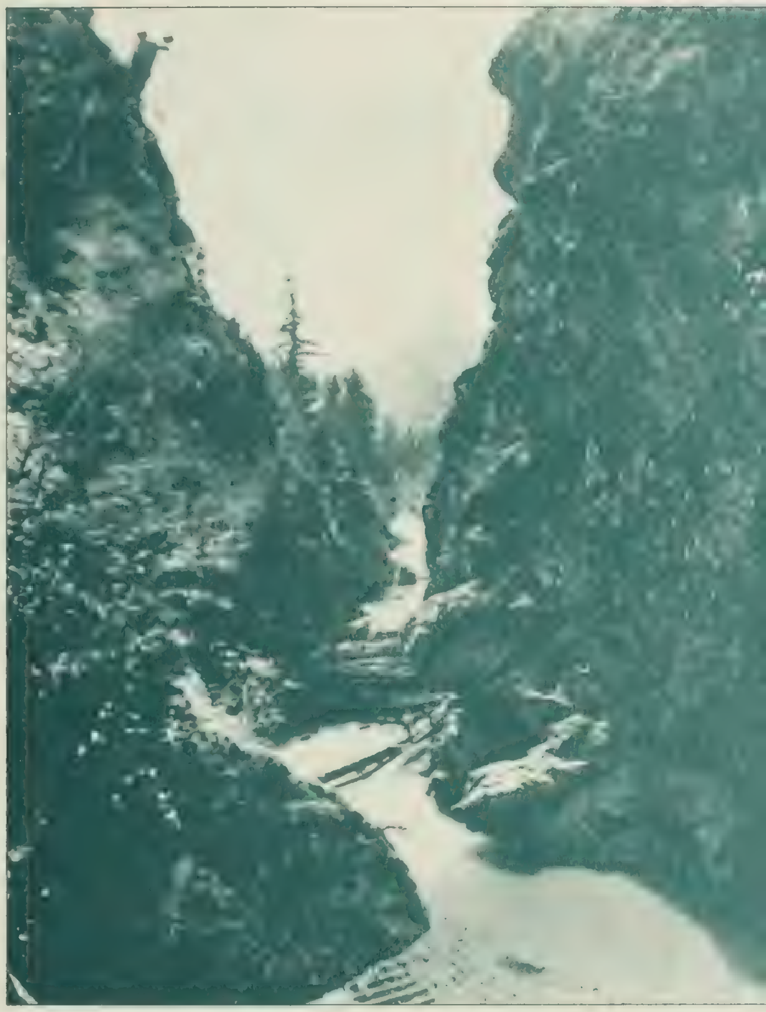
Overall

The Elwha River valley consists of a series of relatively narrow bedrock canyons and wide lower-gradient, flat alluvial sections referred to as bottom lands (or bottoms). Alpine glaciers carved out the wide bottom lands in weaker rock units, whereas canyon sections represent stronger rock units that could not be as easily eroded. The basin topography was influenced both by alpine glaciers flowing from the high Olympic Mountains, where remnants still remain, and the Juan De Fuca lobe of the great Vashon continental glacier, which covered the lower Elwha River.

The Elwha River has a steep slope, steepest at the headwaters (16% average gradient) and generally decreasing in the downstream direction. The river flows through several steep, narrow, bedrock canyons. Between these canyons, the channel is less steep and has wider reaches within its broad floodplains. At the outlet of the canyons, the channel widens, the streamflow slows, and sand, gravel, cobbles and large woody debris are left behind by the slower-flowing river, creating deltas. In the floodplain, the river typically meanders, in some cases undercutting alluvial terrace and valley wall deposits.

Upstream of Lake Mills to Glines Canyon Dam

Geyser Valley (also known as Krause Bottom) is the first wide alluvial bottom land above Lake Mills and consists of a wide, meandering alluvial channel between the upstream Grand Canyon and downstream Rica Canyon. This alternating alluvial-and-canyon form is also typical of the region from Lake Mills to Lake Aldwell, and provides a good illustration of pre-dam conditions at Lake Mills and much of the middle reach of the river. Rica Canyon has steep rock walls and is inundated near its downstream end by Lake Mills. Since the dams have been in place, most of the sediment transported by the Elwha River has deposited within Rica Canyon as large, aggrading bars and in Lake Mills (known as Smoky Bottom before it was covered with water) as delta and lakebottom sediments.



Glines Canyon before dam construction. (Daishowa/James River Company photo)

There are several sources of information about the characteristics of Smoky Bottom, the area now occupied by Lake Mills, before the Glines Canyon Dam was built. A map made prior to dam construction in 1921 and several photographs of the reservoir area taken before inundation (James River II 1987) show a broad, slightly meandering, and locally braided channel with gravel and cobble bars with an average slope of 0.7%. The channel was bordered by extensive, gently sloping terraces up to 800 feet wide (James River II 1990).

Lake Mills now inundates a 2.5 mile stretch of the river. The Glines Canyon Dam has trapped an estimated 13.8 million cubic yards of sediment and created the Lake Mills delta (table 14, BOR 1995d). The upstream portion of the delta in Rica Canyon and Cat and Boulder Creek fans is approximately 1.55 million cubic yards of mostly coarse (i.e., sand-sized and larger) material. The main delta contains 6.97 million cubic yards which is 70 feet thick in some places. Downstream of the delta, 6.6 million cubic yards of fine, lake-bottom sediments are composed primarily of silt and clay, with minor amounts of sand (table 14). This fine material, spread fairly evenly to an estimated 12-foot thickness along the length of the lake, is concentrated in the center of the reservoir and thins toward the edges. Most of the lakebed is composed of silt-sized particles. The clay-size particles have little cohesion and lack many common properties of clay.

Glines Canyon Dam to Elwha Dam (Middle Reach)

The first mile of the middle reach of the river immediately below the Glines Canyon Dam is constrained in a narrow bedrock canyon 80-250 feet wide. From the Altaire bridge on Olympic Hot Springs Road (river mile 12.5) to the McDonald stream gauge (river mile 8.5), the river channel is 200-400 feet wide. Overall channel slope of the middle reach is 0.7%. Different from the river processes that occurred before the dams were built, there is now little reworking of valley alluvium by lateral channel migration in the middle reach. Also, the amount of sand and gravel in the riverbed is noticeably lacking compared to the river upstream from Lake Mills. Downstream of the dam there has been noticeable scouring of fine sediment from channel edges and the floodplain. Sediment in this reach comes from tributaries when they are in active flood stage and from sediment stored along the channel in bars and terraces. Additional information on the impacts of the dams on fluvial processes is in the Impacts of the No Action Alternative, Fluvial Processes section in this environmental impact statement.

Lake Aldwell inundates 2.8 miles of the Elwha River; the reservoir area consists of two wide alluvial reaches divided by a canyon. Approximately 3.88 million cubic yards of sediment are trapped in Lake Aldwell and its delta (table 14, BOR 1995d). The delta contains an estimated 1.78 million cubic yards, as much as 40 feet thick, composed of sand and gravel with smaller amounts of clay, silt, cobbles, and boulders. Downstream of this delta, 2.1 million cubic yards of fine, lake-bottom sediments are composed of fine-grained sediments, with minor amounts of sand. This material is 5-6 feet thick in the southern basin, thinning to less than 1 foot in the narrow canyon section.

Elwha Dam to River Mouth (Lower Reach)

From the Elwha Dam down to river mile 4, the river is constrained by the steep bedrock walls of Elwha Canyon. In the next half mile of the river below Elwha Canyon, the stream gradient is less steep and the channel floodway

Table 14. *Estimated Sediment Gradation and Volumes for Lake Mills and Lake Aldwell*

	CLAY SILT	SAND	GRAVEL	COBBLES	TOTAL
size range (mm)	<0.075	0.075-<5	5-<75	75-<300	(million yd^3)
Lake Mills					
Rica Canyon, Cat Creek, & Boulder Creek fans	.08	.47	.85	.15	1.55
delta area	1.65	4.28	.99	.05	6.97
reservoir floor & prodelta	4.89	.41	0.00	0.00	5.30
TOTAL (million yd^3)	**6.62**	**5.16**	**1.84**	**.20**	**13.82**
Lake Aldwell					
delta area	.72	.85	.16	.05	1.78
reservoir floor & prodelta	1.87	.23	0.00	0.00	2.10
TOTAL (million yd^3)	**2.59**	**1.08**	**0.16**	**.05**	**3.88**

widens to approximately 1,500 feet. The city of Port Angeles Ranney collector (adjacent to the channel) and surface water intake that supplies water to the mills and the state rearing channel are located between river miles 2.8 and 3.0. At river mile 2.8, the river channel is constrained by bedrock on the right bank and narrows through this area.

Between river mile 2.8 and the river mouth, the floodplain widens and is bound on the west side by steep cliffs of glacial deposits more than 150 feet high. The pre-dam river migrated throughout its entire floodplain; nearer the mouth, it moved laterally over an area 1.2 miles wide. The erosion action of the meandering river traditionally prevented the establishment of a mature evergreen forest. Because the channel has shifted less frequently since the dams were built, dense, woody vegetation has grown in near the mouth and serves to increasingly constrain the river in the lower reach. The Lower Elwha Federal Flood Control Levee, situated on the east side of the floodplain, constrains the eastward migration of the river. A 900-foot-long privately owned levee extending downstream from the high river bluffs on the west side of the river near its mouth also restricts the floodplain on its west side.

Coastal Delta Area and Beaches

For thousands of years, erosion and river transport delivered sediment to the Elwha River mouth to form an extensive delta. The delta is roughly 5 miles wide, 6 miles long, and estimated to be 200 feet thick. It is composed of sand, gravel, and cobbles, with samples indicating a sand and gravel surface to approximately 2,000 feet offshore (COE 1971). The dams blocked this natural sediment transport; currently, the only sources of delta sediment are those in the 4.9 miles upstream from the mouth, i.e., erosion of loose material (alluvium) and from the bluffs that lie along the west side of the river. As a result, sediment yields to the delta have dropped from a pre-dam sediment supply of 280,000 cubic yards per year to 5,900 cubic yards per year, approximately 2% of the pre-dam volume (Schwartz 1994; FERC 1993).

Sediment from the Elwha delta moves with the currents in the strait, predominantly in an eastward direction along the coast, nourishing beaches and nearshore areas with sand and gravel, and supplying some of the sediment to Ediz Hook, an above-surface extension of sand, gravel, and cobbles that forms the bayward side of Port Angeles Harbor (FERC 1993, p. 3-20). The drastic reduction in bedload sediment supply from the river has caused some erosion of beaches (75-150 feet of shoreline recession, FERC 1993 p. 3-19) and the western edge of Ediz Hook.

Flooding

The floodplain between the dams (from Glines Canyon Dam to the US Highway 101 bridge at the head of Lake Aldwell) and the 1-mile reach downstream from Elwha Dam (to RM 4) can be characterized as a largely undeveloped, relatively narrow floodplain confined by steep, forested valley side slopes (figure 9). The river gradient in these sections averages 40 feet per mile, and the river flows swiftly. There is no development within the 100-year floodplain on the west side of the river, but four residential properties (three near river mile 8.4, one near river mile 9.7) lie within the floodplain on the east side of the river. These properties are vulnerable to even 5- to 25-year floods. Portions of the Olympic Hot Springs Road (Elwha Valley Road), paralleling the east side of the river channel, and the Elwha and Altaire campgrounds in Olympic National Park also lie within the 100-year floodplain. The Elwha Ranger Station facilities, located near river mile 12.1, are above the 100-year floodplain.

In the broad floodplain between the Highway 112 bridge (at river mile 3.3) and river mile 4, three residential properties on the west side of the river and one on the east side are flooded at frequencies ranging from 10 to 30 years; these lie approximately 3 feet below the current 100-year flood elevation. The Dry Creek Water Association wells and wellhead access road on the east side of the river are also within the 100-year frequency floodplain.

Compared to the middle reach, the floodplain along the river in the lowest 3 miles broadens significantly and has a much lower gradient (approximately 15 feet per mile). Development in this portion of the 100-year floodplain includes a state fish rearing facility, the city of Port Angeles domestic water supply system, the well field for the Elwha Place Homeowners' Association, a federal flood control levee on the east side of the Elwha River, and residences on the west side near the river mouth. These residences on the west side of the river are protected against lower frequency (25- to 50-year) floods by a privately owned and locally constructed levee.

The 7640-foot-long Elwha flood control levee was constructed in 1988 by the US Army Corps of Engineers in the lower 1.5-mile floodplain of the river. Approximately 300 acres of Lower Elwha Klallam Reservation lands between the levee and the river are dedicated to flood abatement in this area. The levee, designed and constructed to withstand a 200-year flood, was built to protect structures in the 700-acre floodplain, including 305 acres east of the levee on Lower Elwha Klallam Reservation and private property. Operation and maintenance of the levee is the responsibility of the tribe, the local sponsor of the project. Structures within the floodplain now protected by this levee include approximately 60 houses, a community tribal center, two churches, a Head Start facility, dental clinic, tribal fish hatchery, and agricultural lands.

The 900-foot-long privately owned and maintained levee on the west side of the Elwha extends downstream to near the mouth of the river from the high natural bluff line, preventing the river from migrating to the west beyond the shore zone. The design and construction criteria for this levee are unknown. Approximately 30 acres of residential development on the west side of the river are provided protection against 25- to 50-year floods. Flooding at the mouth of the river is also influenced by tidal conditions.

Flooding Frequency

The Elwha River typically experiences two periods of high runoff — November through March from heavy rains, and during the spring snowmelt from May through June. Annual peak discharges have ranged from 4,680 cubic feet per second in 1936 to 41,600 in 1897. The greatest recorded discharge in recent years was in November 1990, when 28,700 cubic feet per second (recurrence interval of 14 years) was recorded at the McDonald bridge gauge. Only one homeowner near river mile 2.5 reported being flooded during this event. In 1995, the largest discharge was approximately 14,000 cubic feet per second. Typically, floods are characterized by sharp rises in discharge (usually less than 24 hours to the peak) and a gradual recession of two days or more. It is not uncommon for two or more periods of high flows to follow one another in swift succession.

Both Elwha and Glines Canyon dams are operated in a "run-of-the-river" mode, in which the reservoir level is held constant ...

A frequency analysis of yearly peak discharges shows that a flood of 5,000 cubic feet per second has a 97% chance of being exceeded each year; a 13,000-cubic-feet-per-second flood has a 50% chance of being exceeded each year. The highest measured flood of 41,600 cubic feet per second in 1897 has a 71-year return period. Table 15 illustrates the peak discharges and recurrence intervals for floods on the lower Elwha River.

Both Elwha and Glines Canyon dams are operated in a "run-of-the-river" mode, in which the reservoir level is held constant and very little of the water entering the drainage is stored or released differently from the way it was before the dams were built. Because of this mode of operation, and the small storage volume in the reservoirs, minimal flood protection is provided by the dams and only during short-duration storms or snowmelt.

Since the dams were built, less bedload has been introduced into the lower part of the river, allowing the riverbed to degrade (become lower), which has reduced the flood hazard from pre-dam conditions to some properties along the lower river. Many homes, wells and cultural resources are situated within the 100 year floodplain and are susceptible to flooding now.

Surface Water

Discharge

Annual precipitation in the Elwha River basin ranges from 220 inches in its upper reaches to 35 inches near the mouth of the river. Average annual discharge is approximately 1,500 cubic feet per second. Discharge is influenced by winter storms and spring snowmelt and by baseflow conditions during the summer and fall. The lowest flow period is during late summer and fall, when average discharges range from 618 to 952 cubic feet per second. Flow regimes of the river and its tributaries are nearly natural, as the dams are operated in "run-of-the-river" mode. Sediment discharge and channel morphology in the middle and lower reaches have been altered by the dams,

Table 15. *Peak Discharge and Recurrence Intervals for Flooding in the Lower Elwha River*

DISCHARGE NEAR MOUTH OF ELWHA RIVER (c.f.s.)	RECURRENCE INTERVAL (years)	PERCENT CHANCE THAT THIS FLOOD FLOW WOULD BE EXCEEDED IN ANY GIVEN YEAR
5,000	1	97.0%
13,000	2	50.0%
20,500	5	20.0%
25,800	10	10.0%
33,000	25	4.0%
38,500	50	2.0%
45,000	100	1.0%
50,100	200	0.5%
60,000	500	0.2%

and impoundment of the river in Lake Mills and Lake Aldwell has inundated 5.3 miles of riverine and 684 acres of lowland area.

Two separate high runoff periods are observed on the Elwha River, with greatest discharge occurring during November-March due to heavy winter rain and May-June due to peak snowmelt (table 16). Daily discharge during these months averages 1,300 to 2,300 cubic feet per second.

Minimum daily discharges from 1898 to 1993 have ranged from 10 cubic feet per second in October to 746 in June (table 16). These minimum flows were largely influenced by storage in Lake Mills during drought periods. Average monthly data (table 16) provide a more realistic description of minimum flow conditions under present run-of-the-river operation of Lake Mills and Lake Aldwell. Minimum values for monthly average discharges are lowest during September (330 cubic feet per second), October (241 cfs), and November (219 cfs).

Use

The city of Port Angeles holds 200 of the 206 cubic feet per second of state-issued water rights on the Elwha River — a 50 cubic-feet-per-second groundwater right for municipal purposes at a Ranney well next to the river at river mile 2.8, and a 150 cubic-feet-per-second surface right covering a diversion structure and canal approximately three miles upstream from the river mouth (figure 10). This surface diversion provides water to three users — two large paper and pulp mills and the Washington Department of Fish and Wildlife fish rearing channel. Private landowners, the Dry Creek Water Association (0.6 cubic feet per second) and the Elwha Place Homeowners' Association (0.4) hold groundwater rights. The Lower Elwha Klallam Tribe

Figure 9. *Floodplain Map*
Olympic National Park
United States Department of the Interior - Nati
DSC - December 1995 - 149 - 20070

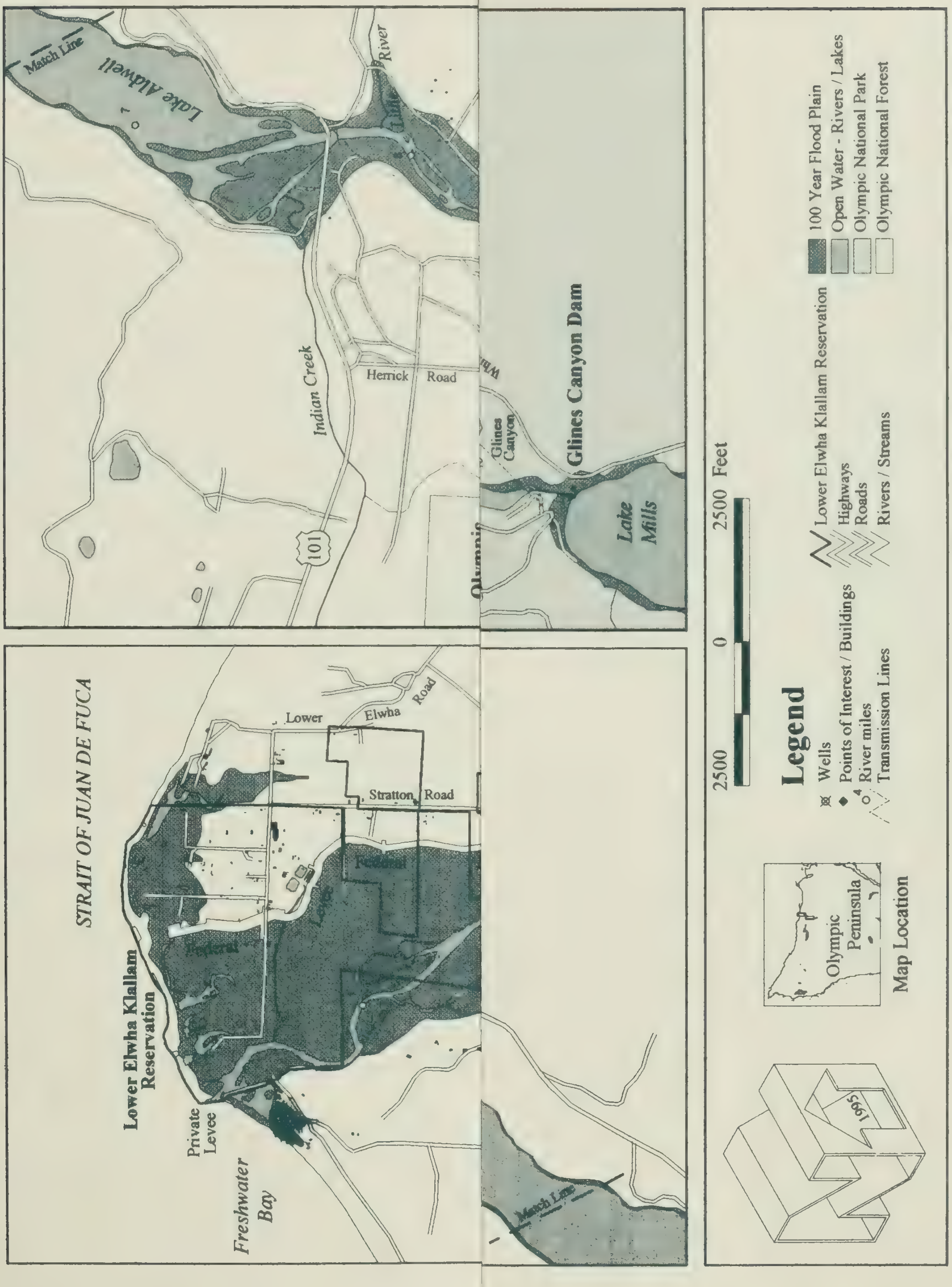


Figure 9. Floodplain Map

Olympic National Park

United States Department of the Interior   National Park Service

DSC   December 1995   149   20070

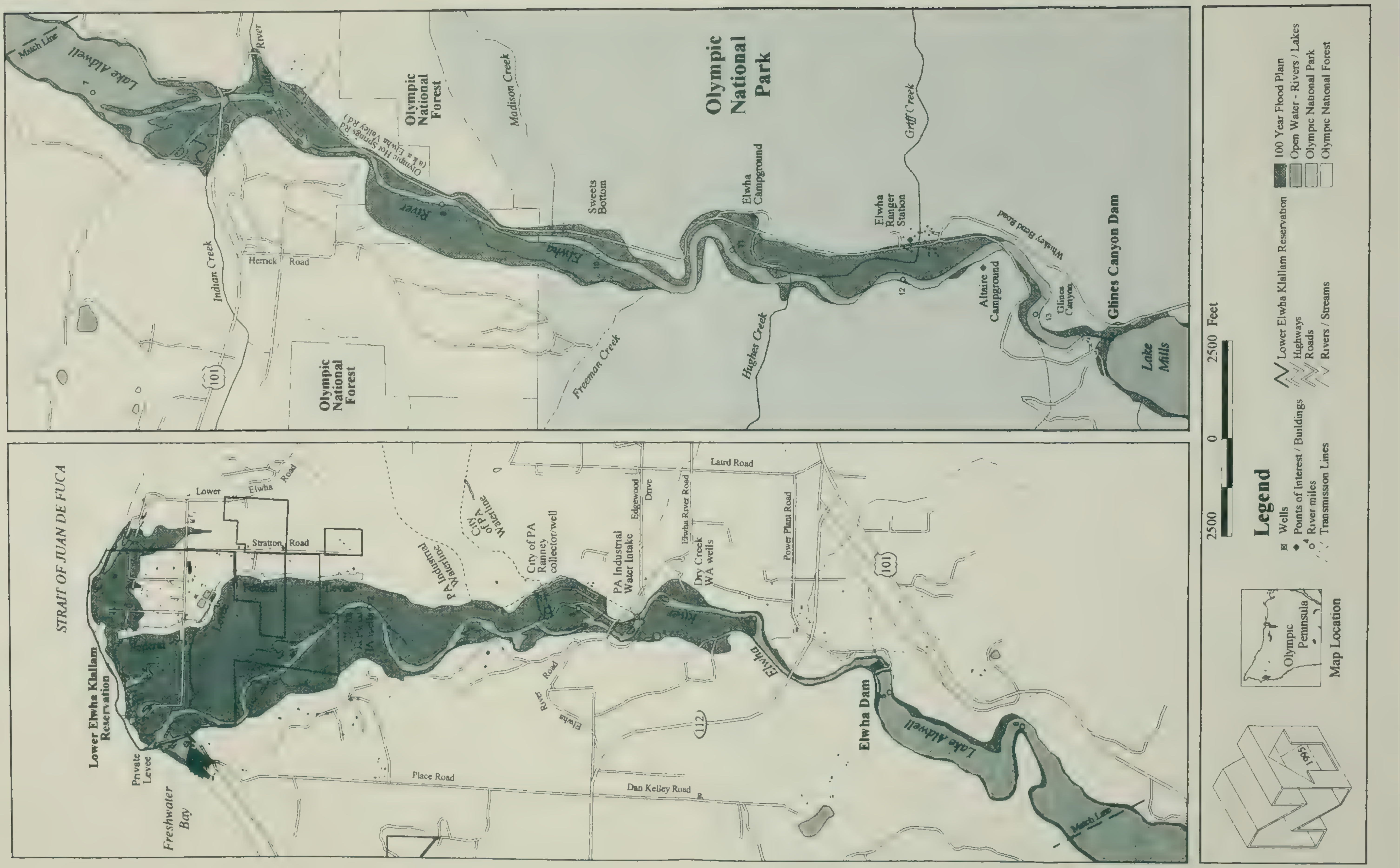


Table 16. *Discharge Statistics for the Elwha River (1898 to 1902, 1918 to 1993)*

MONTH	DISCHARGE (CFS) DAILY MEAN	DAILY MAXIMUM	DAILY MINIMUM	MONTHLY MAXIMUM	MONTHLY MINIMUM	MINIMUM FLOW 1 YEAR IN 10[a]
October	924	11,100	10	2,800	241	418
November	1,634	24,400	40	5,248	219	580
December	2,057	19,700	31	5,111	642	991
January	1,841	18,600	218	4,033	424	820
February	1,681	12,300	90	4,169	476	770
March	1,307	22,400	133	3,307	511	717
April	1,300	10,100	54	2,210	689	764
May	1,937	6,720	499	3,333	962	1,329
June	2,258	8,740	746	4,096	922	1,393
July	1,527	4,540	76	2,917	595	896
August	829	3,320	30	1,642	413	525
September	606	3,680	11	1,385	330	384
Annual	**1,492**	**24,400**	**10**	**5,248**	**219**	—

[a] Monthly average flows are less than the indicated number 10 percent of the years.

SOURCE: USGS gaging station located at McDonald Bridge below Lake Mills (269 mi^2 drainage area)

and Lower Elwha Tribal Fish Hatchery withdraw approximately 10 cubic feet per second. The United States holds additional water rights in trust for the tribe that are not issued by or registered with the state. These rights guarantee sufficient water to support treaty fisheries and the purposes of the Lower Elwha Klallam Reservation.

Water Quality

The Elwha River, its tributaries, and Lake Mills and Lake Aldwell are classified by the Washington Department of Ecology as Class AA waters, signifying "extraordinary" quality. Overall, the Elwha has relatively low concentrations of dissolved and suspended sediment loads, nutrients, and organics. Changes in natural water quality occur in the lower part of the watershed, mostly as a result of reduced sediment load and elevated water temperatures during the summer. Suspended sediment concentrations and turbidity of the lower river are related to reservoir trapping efficiency, flood flows, logging, agricultural practices, and bank erosion.

Water temperatures in the Elwha River are lowest during January and February and highest during August and September (table 17). Seasonal patterns in water temperature are highly influenced by yearly discharge, climatic conditions, and the presence of the dams. Dams have caused water temperatures to be elevated during critical summer months, sometimes severely degrading water quality for fish and other aquatic life in the river.

Values for pH and alkalinity (table 18) indicate neutral to slightly alkaline conditions typical of oligotrophic (low biological productivity) waters (Wetzel 1975). Dissolved oxygen values are very close to saturation at all times of the year; these are excellent conditions for cold water fish (EPA 1976). Most water quality parameters vary little with time except for turbidity and suspended sediments, which increase during high discharge periods.

Nutrient concentrations in the Elwha River are relatively low. Nitrate, ammonia, total phosphorous, and ortho phosphorous concentrations, as shown in table 19, are below those known to limit algal production (Wetzel 1975; Vollenweider 1968). Total phosphorous concentrations for most uncontaminated lakes range from 0.01 to 0.03 mg/l as elemental phosphorous (P) (Hutchinson 1957). The Elwha has an average total phosphorous concentration (as P) of 0.01 mg/l. As a result of these low nutrient concentrations, Lake Mills has very low phytoplankton production and can be considered oligotrophic (Mausolf and Sundvick 1976). Because of low algae production, Lake Mills and Lake Aldwell do not reduce downstream dissolved oxygen or increase turbidity and temperature as a result of biological activity.

The Elwha River, its tributaries, and Lake Mills and Lake Aldwell are classified by the Washington Department of Ecology as Class AA waters, signifying "extraordinary" quality.

Groundwater

An alluvial sand and gravel groundwater aquifer, which supplies municipal and industrial water for local residents and businesses, underlies the Elwha River valley (see BOR 1995a). Five major purveyors withdraw groundwater from the alluvial aquifer: the city of Port Angeles, the Dry Creek Water Association, the Lower Elwha Klallam Tribe, the Lower Elwha Klallam Tribal Fish Hatchery, and the Elwha Place Homeowners' Association. Washington Department of Health water supply monitoring records indicate that the groundwater is of high quality.

Regional Hydrological Setting

The depth, size, orientation, and flow characteristics of a groundwater aquifer are determined by basin geology. In the Elwha basin from Lake Aldwell into the upper portions of the drainage, bedrock has been folded and faulted by the geologic events that formed the Olympic Mountains. At river mile 14, approximately one-half mile upstream of Glines Canyon Dam, the Hurricane Ridge Fault crosses the Elwha River valley (see figure 12). Farther downstream, in the Lake Mills area, the bedrock dips at an 80-degree angle to the south. This prevents groundwater, or surface water from Lake Mills, from flowing north into downstream aquifers. In the lower Elwha River basin, the bedrock is overlain by younger unconsolidated deposits. Since the rock impedes flow, the groundwater is primarily contained in the overlying unconsolidated deposits.

Figure 10. *Northern Study Area*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20069

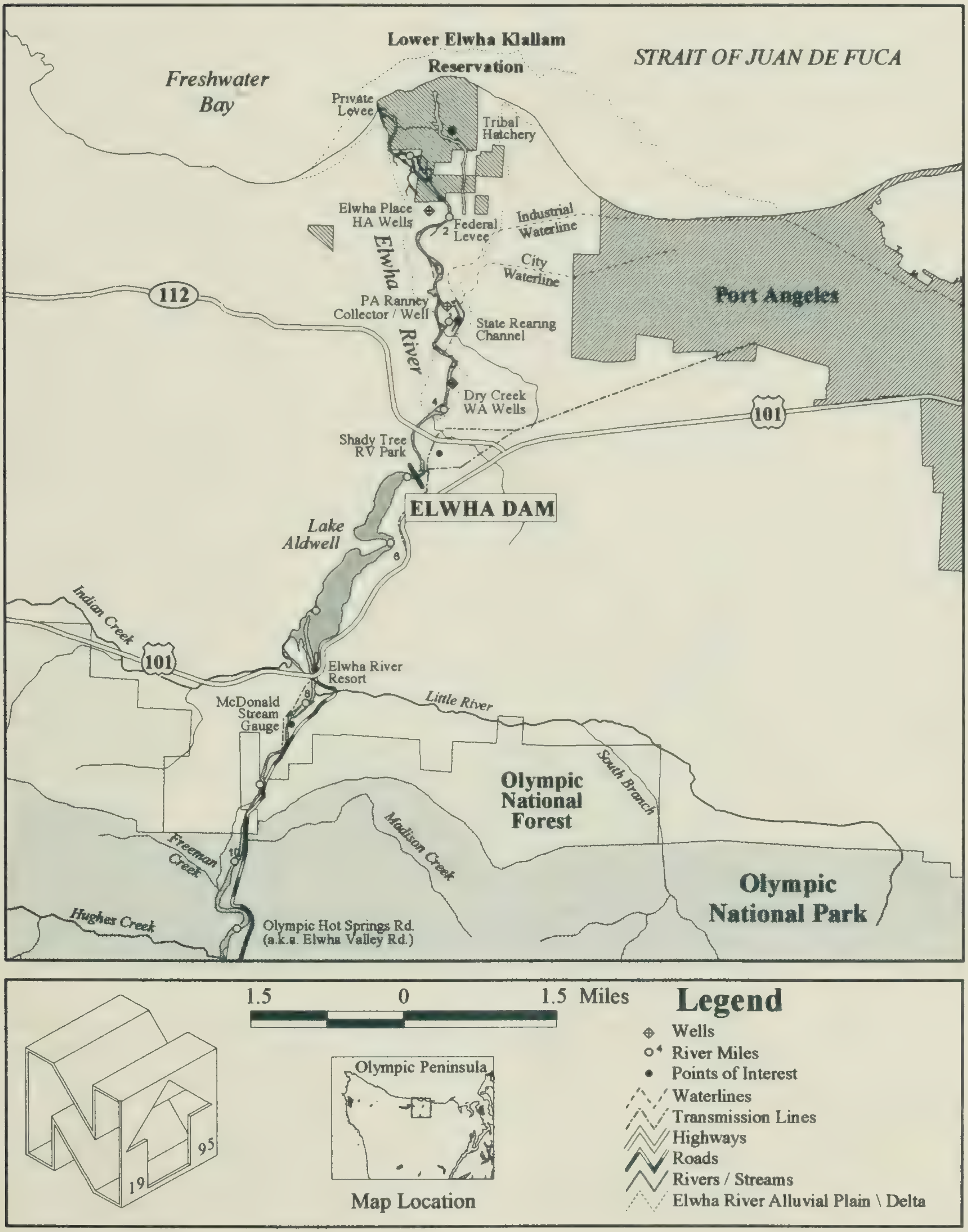


Table 17. *Maximum Daily Water Temperatures for the Elwha River at River Mile 3.3 (1987 to 1989, degrees Celsius)*

	MEAN	RANGE
January	3.7	2.2 - 7.2
February	3.8	0.0 - 6.7
March	5.2	1.1 - 7.8
April	7.4	5.0 - 8.9
May	9.3	8.3 - 11.1
June	11.3	9.4 - 14.4
July	12.6	9.4 - 16.1
August	14.8	11.1 - 18.9
September	14.6	11.7 - 19.4
October	12.3	6.1 - 17.8
November	7.5	2.8 - 13.3
December	4.3	2.2 - 8.9

SOURCE: WDFW fish hatchery records.

A sequence of alluvial, glacial, and non-glacial deposits comprises the unconsolidated hydrogeologic system in the lower basin. The older glacial and non-glacial units were deposited first, covering the bedrock surface that slopes downward toward the north. The Elwha River valley is cut into these deposits. Recently deposited alluvial sediment (i.e., carried by the river) partially fills the valley floor. The width of the alluvium is restricted by relatively steep bedrock and glacial deposit bluffs. The glacial deposits yield water at rates generally less than 20 gallons per minute. Deposits of sand and gravel found at the top of the bluffs are unsaturated and do not serve as a water supply source.

Alluvial Aquifer Characteristics (lower Elwha River)

Above Elwha Dam, the alluvial aquifer is restricted to the river channel and narrow floodplain within the valley and is bounded primarily by bedrock. The alluvium thickens and laterally extends into the lower Indian Creek valley.

Below Elwha Dam, the Elwha River valley is divided into three distinct alluvium filled groundwater sub-basins separated by bedrock outcrops or constrictions in the surrounding glacial deposits. The upper sub-basin lies between river miles 4.0 and 3.1, where the river emerges from narrow, bedrock-walled Elwha Canyon downstream of the dam. The thickness of the 60-acre upper sub-basin is estimated to be as much as 75 feet. Dry Creek Water Association wells are located at the lower end of the upper sub-basin.

Table 18. *Water Quality Statistics for the Elwha River (October 1985 to September 1986[a])*

PARAMETER (UNITS)	MEAN	MINIMUM	MAXIMUM	STANDARD DEVIATION
Discharge (cfs)	1,171	631	1,900	473
Conductance (umhos/cm)	93	80	108	11
pH	7.7	7.2	7.9	.3
Temperature (oC)	7.8	3.0	13.5	4.7
Turbidity (NTU)	2.3	1.5	3.8	1.0
Oxygen, Dissolved (mg/l)	11.8	9.8	13.3	1.5
Percent D.O. Saturation	98	97	100	2
Hardness (mg/l as CaCO3)	41	37	46	4
Alkalinity (mg/l as CaCO3)	37	32	40	3
Dissolved Solids (mg/l)	57	49	68	3
Suspended Sediments (mg/l)	4	1	7	2
Nitrate Nitrogen (mg/l as N)	.1	<.1	.1	—
Ammonia Nitrogen (mg/l as N)	.02	.01	.04	.01
Phosphorous, Total (mg/l as P)	.01	<.01	.04	—
Ortho phosphorous (mg/l as P)	.01	.01	.02	0.0

[a] Samples obtained on a bi-monthly basis.

SOURCE: USGS Gauging Station at McDonald Bridge, river mile 8.6.

The middle groundwater sub-basin is approximately 70 acres between river miles 3.1 and 2.8 and includes the Port Angeles Ranney collector. The lower sub-basin, approximately 1,100 acres downstream of river mile 2.8 to the river mouth, includes the Elwha Place Homeowners' Association wells and the Lower Elwha Klallam Reservation. Drilling in the middle and lower sub-basins showed alluvium thicknesses of 55 feet to 125 feet, respectively.

The yield of the aquifer varies according to local soil conditions. Large wells completed in the alluvium typically yield more than 100 gallons per minute, with maximum reported yields in excess of 1,000 gallons per minute. The hydraulic properties of the alluvium aquifer were tested during development of public water supply wells. Capacities of the wells vary from 10 gallons per minute per foot of well drawdown to more than 100 gallons per minute per foot. The transmissivity of the aquifer increases from upstream to downstream. In the upper sub-basin, the transmissivity is estimated to be 75,000 gallons per day per foot of aquifer; in the middle, 100,000; and, in the lower basin, approximately 400,000 gallons per day per foot of aquifer.

Groundwater Quantity and Use

The alluvial aquifer and the river are hydraulically connected, and both surface and groundwater flow north toward the Strait of Juan de Fuca. Groundwater flow through the aquifer increases from the upper to the lower sub-basin. The discharge from the middle to the lower sub-basin is approximately 1 to 2 cubic feet per second. In the lower sub-basin, the river "loses water" to the aquifer; the US Geological Survey estimates that groundwater discharges from the alluvial aquifer to the strait at a rate of approximately 6 cubic feet per second.

Total use by the five major groundwater purveyors in the Elwha River valley is approximately 22.3 cubic feet per second. In the upper sub-basin, the Dry Creek Water Association holds a groundwater right for 0.6 cubic feet per second and average use is approximately 0.33 cubic feet per second (150 gallons per minute). The association wells are located at approximately river mile 3. Because of their proximity to the river channel, turbidity in the river increases turbidity in their well water supply.

In the middle sub-basin, the city of Port Angeles holds a groundwater right for 50 cubic feet per second. The city's Ranney collector, a large diameter caisson located near the river's edge with laterally radiating perforated collection pipes beneath the riverbed, has the capacity to pump approximately 17 cubic feet per second. There is little indication that river water quality affects the Ranney collector water supply.

In the lower sub-basin, the Lower Elwha Klallam Tribe and the Lower Elwha Tribal Fish Hatchery together withdraw a total from both wells and a shallow infiltration gallery of approximately 10 cubic feet per second. The Elwha Place Homeowners' Association holds a groundwater right for 0.4 cubic feet per second and uses approximately 0.1 cubic feet per second. The Homeowners' Association wells are located in the Elwha floodplain at approximately river mile 1.4, only 1 foot above the 100-year frequency flood level; their water supply does not become turbid when the river does. Other individual groundwater withdrawals amount to less than 0.2 cubic feet per second.

Groundwater Quality

The groundwater in the Elwha River watershed is of excellent quality; the entire headwater area is protected within Olympic National Park. The watershed land use is primarily rural, but non-point source pollution from agricultural and urban land use areas has a minor influence on groundwater quality. Low chloride levels (less than 1 milligram per liter to 8 milligrams per liter) detected in wells near the mouth indicate that saltwater intrusion has not occurred to date. Private septic systems in the lower basin present a potential for groundwater contamination because of the poor filtering capability of the coarse-grained alluvial soils and the high water table.

The city of Port Angeles, Dry Creek Water Association, and Elwha Place Homeowners' Association groundwater withdrawals have been periodically tested for several contaminants as required by the Washington State Department of Health. Well water tested for turbidity, coliform bacteria, inorganic chemicals, trihalomethane, volatile organic chemicals, and pesticides was found to be of very high quality: volatile organic chemicals were not detected in any samples; inorganic maximum contaminant levels were not exceeded in any samples taken from Dry Creek Water Association (1990 to 1993) or Elwha Place Homeowners' Association wells (1985 to 1993); trihalomethane concentrations were below the maximum contaminant levels in all Port Angeles (1988 to 1993) and Dry Creek (1989 to 1994) samples.

Only two constituents, iron and turbidity, were detected above maximum contaminant levels in the Port Angeles Ranney well samples taken from 1983 to 1993. Although the mean iron concentration of 0.2 milligrams per liter was below state drinking water standards of 0.3, the maximum concentration detected was 1.0 milligram per liter. Samples of fine lakebottom sediment from Lake Mills were tested and found to contain high pore water concentrations of iron (average of three samples was 27.5 milligrams per liter) and manganese (average of three samples was 4.67 milligrams per liter). The dissolved iron and manganese concentrations could remain elevated with additional leaching from the sediment during dam removal, and cause iron fouling of groundwater delivery systems and mineral staining of fixtures and clothing.

Turbidity of the Ranney well water is lower than in the river because alluvial sands and gravels filter out a large portion of the particulate matter, the 1994 measured mean turbidity of 0.08 NTU (nephelometric turbidity units — a measure of how intensely light is scattered by particles in the water) does not exceed drinking water standards of 1.0 NTU. The maximum turbidity detected in the city's well from 1983 to 1993 was 4.8 NTU. All other inorganic constituents, including copper and lead, were detected at lower than state maximum contaminant levels.

The US Geological Survey tested water resources of the Lower Elwha Klallam Reservation in 1977 and found them to be of excellent chemical quality. The Lower Elwha Klallam Tribe has sampled two of their community wells for complete inorganic and organic analysis. All parameters tested were lower than state maximum contaminant levels.

The groundwater in the Elwha River watershed is of excellent quality; the entire headwater area is protected within Olympic National Park.

Native Anadromous and Resident Fisheries

Ten stocks of anadromous salmon and trout are either now present in the Elwha River or, based on data from neighboring rivers or other information, were present before the dams were built. They are winter and summer steelhead trout, coho, summer/fall and spring chinook, pink, chum and sockeye salmon, cutthroat trout, and native char (Dolly Varden and bull trout). In addition to these anadromous species, the Elwha harbors many non-migrating fish, including threespine sticklebacks, sculpins, resident cutthroat, rainbow, and native char, and marine species such as flounders are found in the estuary. White sturgeon and smelt also have been observed in this river in the past.

The Elwha River was legendary for its production of huge chinook; fish in excess of 100 pounds were recorded as late as 1930, 18 years after the closure of Elwha Dam (Brannon 1930). The river also was known as a producer of large quantities of pink and chum salmon. Although pink salmon were numerous through the 1960s, they appear to have died out by the late 1980s.

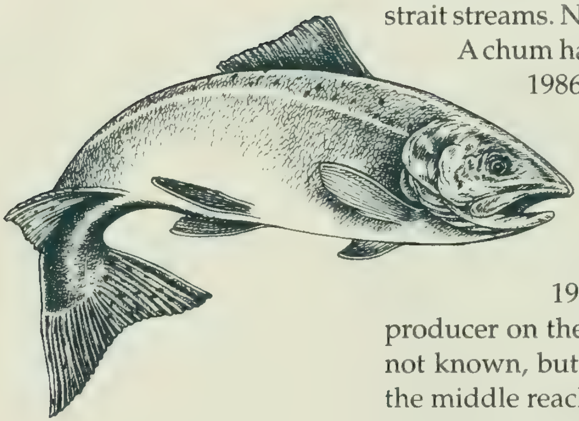
Approximately 70 miles of the mainstem river and its tributaries are estimated to have been available to anadromous species before the dams were built. Steelhead and possibly other species could have traveled as far as 43 miles up the 45-mile mainstem channel before encountering impassible stretches (James River II 1988). Carlson Canyon Falls at river mile 34 (see figure 8) may have blocked some species, depending on timing and condition of the fish. It is unknown but widely speculated that the relatively poor jumping ability of pink and chum salmon may have restricted them to the region below Rica Canyon (river mile 16) (James River II 1988).

Elinor Chittenden displays a steelhead caught in 1907, before the Elwha Dam was constructed. (Asahel Curtis photo, Washington State Historical Society)

Table 19. *In-River Life Cycle Stages of Elwha Salmonids*

	Months											
Elwha Salmonids	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Summer/Fall Chinook												
Adult inmigration							■	■	■			
Adult spawning									■	■		
Juvenile outmigration	■	■	■	■	■	■	■	■	■	■	■	■
Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
Spring Chinook												
Adult inmigration				■	■	■						
Adult spawning								■	■			
Juvenile outmigration	■	■	■	■	■	■	■	■	■	■	■	■
Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
Coho												
Adult inmigration								■	■	■	■	■
Adult spawning										■	■	■
Juvenile outmigration			■	■	■	■						
Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
Pink Salmon												
Adult inmigration							■	■	■			
Adult spawning								■	■	■		
Juvenile outmigration			■	■	■	■						
Juvenile rearing			■	■	■	■						
Chum Salmon												
Adult inmigration										■	■	
Adult spawning	■									■	■	■
Juvenile outmigration			■	■	■	■						
Juvenile rearing			■	■	■	■						
Sockeye Salmon												
Adult inmigration			■	■	■	■	■	■	■	■	■	■
Adult spawning	■									■	■	■
Juvenile outmigration			■	■	■	■	■					
Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
Winter Steelhead												
Adult inmigration	■	■	■									■
Adult spawning	■	■	■	■								■
Juvenile outmigration				■	■	■	■					
Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
Summer Steelhead												
Adult inmigration				■	■	■	■	■	■			
Adult spawning	■	■	■	■								
Juvenile outmigration				■	■	■	■					
Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
Cutthroat Trout												
Adult inmigration	■							■	■	■	■	■
Adult spawning	■	■	■									
Juvenile outmigration			■	■	■							
Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
Char												
Adult inmigration								■	■	■		
Adult spawning										■	■	
Juvenile outmigration				■	■	■						
Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■

The Elwha River is currently the largest producer of steelhead and chinook salmon on the Strait of Juan de Fuca and is second only to the Dungeness River for coho. Though salmon and steelhead run sizes in the Elwha appear minor in relation to Washington State's total production, they are significant contributors to the Strait of Juan de Fuca and Vancouver Island fisheries, with the exception of chum salmon production which is small compared with other strait streams. Nearly all chinook, coho, and steelhead are hatchery-produced. A chum hatchery program operated for 10 years, but was abandoned in 1986.



Resident sport fish in the river system are dominated by rainbow trout and, to a lesser degree, native char. A very small number of cutthroat trout and brook trout are also present (Morrill and McHenry 1995; Mausolf and Sundvick 1976; Collins 1983). The Elwha drainage is a major wild trout producer on the Olympic Peninsula. Its ranking to other regional streams is not known, but a creel survey conducted on Lake Aldwell, Lake Mills, and the middle reach indicated a high fishing effort (approximately 22,000 hours seasonally, Collins 1983). See the socioeconomic section for more information about tribal, commerical, and recreational fisheries.

Chinook Salmon

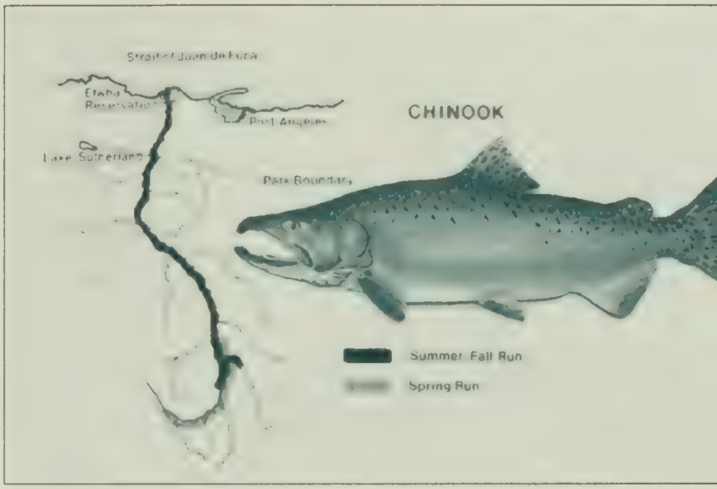
Chinook salmon are described by the season in which they enter their natal streams to spawn. Spring chinook enter fresh water several months earlier than summer/fall chinook. Before the dams were built, it is believed that chinook entering the river in the spring swam farther upriver and spawned upstream of Carlson Canyon Falls at river mile 34. Fish entering in the late summer or fall spawned downstream of river mile 34.

Chinook enter the Elwha River primarily from June through September (see table 19). Adults require cool water (below 14°C) and medium-size spawning gravel, usually laying their eggs in a main channel of the river rather than its side channels or tributaries. Peak spawning occurs from September through mid-October, and adults die within days or weeks of spawning. Juveniles either migrate out their first spring or rear in the river and leave the following May and June as yearlings (Williams et al. 1975). All spend some time in the estuary as they grow and adapt to salt water. Native Elwha underyearlings move into the offshore marine environment in late July and early August (Schroder and Fresh 1985).

Records show that chinook have been regularly stocked for many years. As early as 1930, E.M. Brannon, supervisor of the Dungeness Fish Hatchery, proposed the stocking of chinook in the Elwha. By 1945, the program was in full implementation (Port Angeles Evening News 10/3/45). The major stock has been Elwha River summer/fall chinook; spring chinook planted in 1973 and 1977 were from Dungeness and Sol Duc hatchery stocks. For the period 1985-present, approximately 775,000 chinook yearlings have been released annually, with fry and fingerlings totaling 2.6 million fish per year (PSMFC 1995).

Coho Salmon

Coho salmon are another highly prized sport and commercial salmon species in Washington. The Elwha River, because of its hatchery program, is currently one of the largest producers of coho on the Strait of Juan de Fuca. Run size is a small portion (less than 1%) of the total Puget Sound coho production, but accounts for approximately 35% of the runs returning to the North Olympic Peninsula (WDFW 1995b).

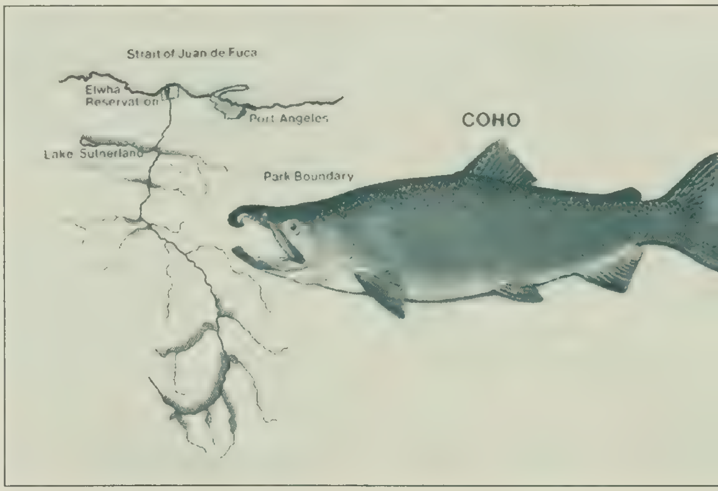


Chinook salmon historic spawning habitat on the Elwha River.

Adults enter the river from mid-August through early December, with some arriving as late as January. Spawning takes place from October into December, typically in gently sloping (1–3%) tributary habitats, although adults can use main or side channel habitat. Coho adults die shortly after spawning. Most juveniles emerge from the gravel from late winter through mid-spring (Williams et al. 1975; Scott and Crossman 1973). Juveniles live for over a year in the system before migrating to the ocean from late March through mid-June; peak outmigration occurs in May (Wunderlich 1983). Overwintering habitat, which is critical for survival, is often associated with wooded off-channel areas such as ponds and side channels, though main channel pools also are used (Peterson 1980; Peterson and Reid 1984; Swales and Levings 1985).

Coho are typically released from the hatchery into the river as yearling fish in April and May. Recent releases (1990–94) ranged from 0.4 to 0.8 million smolts per year. Since 1977, coho returns to the Elwha have varied from as high as 16,000 to as low as 1,100 fish per year, with the majority being hatchery fish. For the 1990–1994 period, the average return to the river was just under 3,000 coho per year (PNPTC and Makah Tribe 1994).

Coho salmon historic spawning habitat on the Elwha River.



Pink Salmon

Pink salmon are a major commercial salmon species in Puget Sound, returning primarily every odd year. Elwha River pink salmon production has dramatically declined since 1979, and the stock may now be extinct. The 1979 decrease in pink salmon returns was a regional occurrence with similar large decreases in the Dungeness River, the other major pink salmon bearing river in the strait. This crash corresponds to a year of heavy rains and flooding, though the lack of suitable riverine habitat caused a subsequent long-term decline (WDFW et al. 1994).

Pink salmon adults enter the river from July through September, spawning in smaller sized gravels within low gradient channels and tributaries. Eggs deposited in the stream bed gravels incubate during the winter and hatch in early spring. Juveniles emerge from the gravels and move downstream toward the sea within hours or days of hatching. Because they are so small, they are not as strong swimmers as older juveniles of other species and are largely swept by the downstream current to the river mouth and estuary, where they grow and feed. Juveniles spend up to two months maturing in estuaries or nearshore marine habitat before moving into deeper water.

There has been no hatchery program for Elwha pink salmon since the failed hatchery program in the 1920s. Peak runs and escapement to the river since 1959 were nearly 40,000 (in 1963). Since 1979, however, estimated runs and escapement have been in the hundreds; since 1989, probably fewer than five fish annually (WDFW et al. 1994).

The historical upstream distribution of pink salmon is not known. However, based on increasing stream gradient, it is assumed that they did not migrate above river mile 16, about the upper end of Lake Mills. Therefore, habitat below that point, including the inundated reservoir areas, is critically important to pink salmon.

Chum Salmon

Chum salmon are a major commercial species in Puget Sound, infrequently captured by sport anglers. The historic Elwha River chum run, like the Elwha pink run, was considered abundant. During the last two decades, though, the Elwha River has been a small contributor to total strait chum production and a very small portion to Puget Sound with runs to the Elwha River typically less than 1,000 fish and peaking in 1980 at 1500.

Native chum salmon migrate to the Elwha from September through early December with the majority entering in October and November. Spawning occurs from October into January in smaller sized gravels in low grade channels and tributaries. Rearing and outmigration is very similar to pink salmon. Fry emerge from the gravel from March through early June and migrate directly to the estuary or ocean (Williams et al. 1975; Scott and Crossman 1973; Salo 1991). Puget Sound chum spend their first few weeks in the marine environment in shallow water (less than 1 meter) before moving gradually offshore (Gerke and Kaczynski 1972).

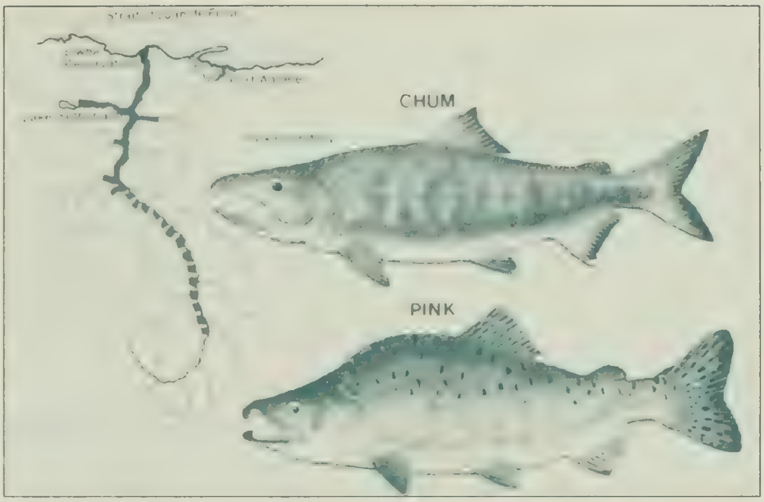
In 1977, the tribal fish hatchery began stocking chum fry from the Quilcene hatchery (Walcott Slough stock) into the Elwha River and used returning fish for broodstock beginning in 1980. This continued until 1986, with releases averaging 0.8 million fry per year (PSMFC 1995). Production was discontinued primarily due to poor adult returns and low market value.

The historical upstream distribution of chum salmon is not known. However, chum are the poorest jumpers of all Elwha River salmon, and it is assumed that they did not migrate above river mile 16. Habitat in the middle and lower river is therefore particularly important to this species.

Sockeye Salmon

Sockeye salmon are one of the most prized commercial salmon species in Washington, although state-originated runs are small.

All major stocks of sockeye require a river system with a connected lake for spawning and rearing purposes. The only lake in the Elwha River drainage is Lake Sutherland, now inaccessible because of Elwha Dam. Lake Sutherland drains into Indian Creek, which enters the Elwha at river mile 7.5, between the two dams (see figure 8). Records (1982-1991) show an in-river harvest of only eight sockeye total over the ten-year period (Hoines 1994); these fish were probably strays, and could have come from coastal (Ozette or Quinault), Puget Sound (Baker or Lake Washington), or Fraser River runs. There are no hatchery operations for sockeye on the Elwha River.



Pink and chum salmon historic spawning habitat on the Elwha River (solid line is known habitat; dashed line is additional possible habitat if fish can migrate through Rica Canyon).

Steelhead

Steelhead trout, an anadromous race of rainbow trout, are one of the most sought-after sport fish in the state and also support substantial tribal commercial harvest. Because of the tribal hatchery program, the Elwha River is the largest producer of steelhead in the Strait of Juan de Fuca. Although the Elwha ranked tenth highest among state streams for winter steelhead sport catch in 1987–1988, this ranking has declined in recent years (WDF 1988, WDFW 1993).

Winter steelhead enter the Elwha December through March or early April, while summer steelhead migrate upstream from late April through September. Summer steelhead reside in the river for up to six months before spawning (Wydoski and Whitney 1979), and both races spawn in the spring. Most juveniles rear in the river for two years before migrating to the ocean, although rearing ranges from one to three years. Approximately 5% of adults migrating upstream have spawned before. Adults that spawn and return to the ocean are called "kelts" on their trip out to sea.

Steelhead spawn in mainstem and tributary streams and use a wide range of substrate sizes from fine gravel to medium cobble. Rearing juveniles use both tributary and mainstem habitat. Moderate to high gradient habitat (0.5–5.0% slope) is generally the most productive for rearing steelhead (Gibbons et al. 1985).

As typical for other streams in the area, the winter run is larger, accounting for more than 80% of the total steelhead harvest. Beginning about 1979, the

Lower Elwha Tribal Fish Hatchery began to rear winter steelhead and has continued to collect stock returning to the Elwha for rearing and release. This facility is now the primary source of winter steelhead for the river.

Approximately 3,100 winter adults enter the river from an average of 82,000 hatchery smolts released each year (PSMFC 1995). The Lower Elwha Klallam Tribe operates a commercial in-river fishery for hatchery run winter steelhead; these harvests average 1,450 fish per year for the tribe (PNPTC and WDFW 1994). Sports anglers additionally harvest an estimated 1,150 winter and 355 summer steelhead each year (PNPTC and WDFW 1994).

Searun and Resident Cutthroat Trout

Both a resident and anadromous race of cutthroat trout were probably present in the pre-dam Elwha River. Searun cutthroat trout are a major sport species in the state although they are less abundant than steelhead in most areas (Johnston and Mercer 1976; DeShazo 1980). A regionwide decline in searun cutthroat populations has occurred in the past 15 to 20 years (Trotter 1989).

Searun cutthroat are not abundant in the lower river, though they are caught incidentally (fewer than five annually) during other in-river fisheries. Similarly, resident cutthroat trout are not numerous in the upper reaches of the Elwha (Morrill and McHenry 1995), though small numbers were found in the middle reach, particularly in Indian Creek. In a 1981–82 creel survey of Lake Aldwell and Lake Mills, no cutthroat were observed (Collins 1983). It is possible that more isolated populations may be present farther up tributary streams in this system, since cutthroat are often present in these areas in the state (Trotter 1989). Hatchery outplanting of cutthroat into nearby Lake Sutherland averaged 10,500 fish annually, for the period 1982–91, except 1984 (WDFW 1993).

Adult anadromous cutthroat trout migrate upstream from July to January at least once before they are ready to spawn. Spawning occurs from December to March, most often in low-gradient tributaries of small or moderate-sized streams (<46 mi^2), draining sloughs, or meadowlands (Trotter 1989). As many as 40% are repeat spawners. Fry emerge in late spring. Cutthroat juveniles mature in and live for several years in their natal streams before migrating as smolt. Generally, fish from coastal stocks leave later (age five) than do fish from inner Puget Sound (most at age two). Outmigration is from March to May. Adults in the marine environment stay within 30 miles of their stream of origin.

Native Char

Native char (Dolly Varden and bull trout) populations in Washington are minor sport species because of their limited abundance. Little is known about the species in Washington. They are widely distributed in the state, but not locally abundant (Thom Johnson, per. comm., WDFW, April 6, 1990). Like cutthroat, there are both anadromous and freshwater races.

Anadromous populations migrate from the sea upriver from May to December (usually August to September) with spawning occurring in the fall, usually October. Fry emerge in April to mid-May. Anadromous stocks migrate to sea at age three or four in the spring and return to the same river in the fall, spending only late spring to fall in the marine environment each year of their life. Like cutthroat, char migrate only a short distance from the river in the marine phase and spend the entire time in tidal water (Scott and Crossman 1973). In systems with lakes, resident fish may undergo similar migrations, spending summers in the lake and other times in the river (Wydoski and Whitney 1979).

Resident Rainbow Trout and Other Species

Rainbow trout and small populations of brook trout (nonnative) occupy the upper Elwha, as well as the reservoirs and middle reach of the river. These are non-anadromous populations of trout, although the impulse for rainbow to migrate to sea may remain.

The life history of rainbow trout is similar to the steelhead. They spawn from April to June with fry emerging in early to mid-summer, depending on temperature (Scott and Crossman 1973). Rainbow trout are well adapted to Northwest streams, commonly residing in most regions of a watershed including lakes, mainstem rivers, and tributary streams.

The creel survey conducted by Collins in 1983 found slight differences between rainbow stocks in Lake Mills and those in the middle reach and Lake Aldwell. Rainbow trout in Lake Mills were generally larger and more abundant for the same age than those in the middle reach and Lake Aldwell. He concluded that the rainbow population characteristics (i.e., size, distribution, and abundance) in all areas sampled were probably controlled by angler harvest. Although fishing restrictions have been imposed since this study, some anglers still believe the fishing has not improved and that other factors (e.g., food availability, water quality, and habitat conditions) may be affecting populations.

There have been sporadic plantings of rainbow trout in the Elwha River, the two reservoirs, and Lake Sutherland. In the latter case, the most recent fish plants were 1982–84 and 1992, ranging from 1,300 to 17,000 fish annually (WDFW 1993). These fish were to supplement a recreational fishery on the lake, though some portion of the fish likely escape the lake and move downstream into the mainstem Elwha River and reservoir.

Other fish that may occur in the Elwha River include dace, peamouth, suckers, threespine stickleback, sculpins, whitefish, smelt, and sturgeon. Sturgeon are a major commercial and recreational species in Washington with the most important stocks utilizing the Columbia and Chehalis rivers. While resident populations occur in the largest Northwest rivers (i.e., the Columbia), most stocks are anadromous. They are occasionally taken in tribal net fisheries in the Elwha River (James River II 1988). See the socioeconomic section for more information about tribal, commerical, and recreational fisheries.

Vegetation

The Elwha and Glines Canyon dams are located within the western hemlock zone, the most extensive vegetation type in western Washington and Oregon (Franklin and Dyrness 1973). This zone is characterized by a wet, mild, maritime climate with relatively dry summers. The plant communities have been shaped by different moisture regimes that reflect elevation, soil type, slope, aspect, and location. Throughout this zone, plant communities are characteristically dominated by western hemlock and Douglas-fir.

The Elwha River, located in the middle of the Olympic Peninsula, has a north-south orientation and is one of the longest drainages on the peninsula. Because of its length and depth, the Elwha valley is quite cold and experiences a climate transitional between the drier conditions to the east and the wetter climate to the west. As a result, the valley supports a mix of unique plant communities that are transitional between the vegetation of the east and the west side of the Olympic Peninsula. Madrone, Douglas-fir/manzanita, and Douglas-fir/ grand fir communities on dry, well drained sites represent eastern peninsula vegetation types found in the valley. Forests dominated by western hemlock with an understory of ferns occur on moist sites throughout the valley and are more characteristic of western peninsula vegetation (table 20).

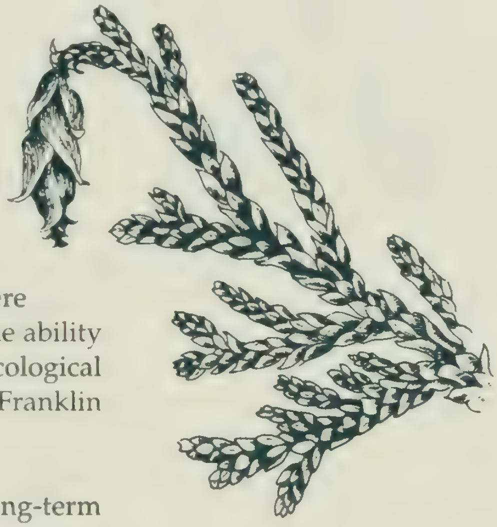
Table 20. *Vegetation Cover Types in Elwha and Glines Canyon Study Area*

	TOTAL ACRES	% OF LAND IN STUDY AREA
Conifer Forest	1,379	43.1
Mixed Forest	589	18.4
Hardwood Forest	535	16.7
Deciduous Shrub	47	1.5
Grasslands	64	2.0
Palustrine Forest	206	6.4
Palustrine Scrub/Shrub	54	1.7
Palustrine Emergent	1	0.0

SOURCE: Compiled from James River II 1988, 1990.

Studies to determine vegetation types were conducted on 3,197 acres on (1) property owned by James River Corporation bordering Lake Aldwell; (2) land adjacent to Lake Mills; (3) Sweets Bottom, bordering the Elwha between Lake Aldwell and Lake Mills; (4) Krause Bottom, the area immediately upstream of Lake Mills; and (5) property owned by James River Corporation in the vicinity of the McDonald Gauge and South Highway 101 (James River II 1988, 1990). Eight vegetated (see table 20) and four nonvegetated cover types were identified.

Riparian Communities



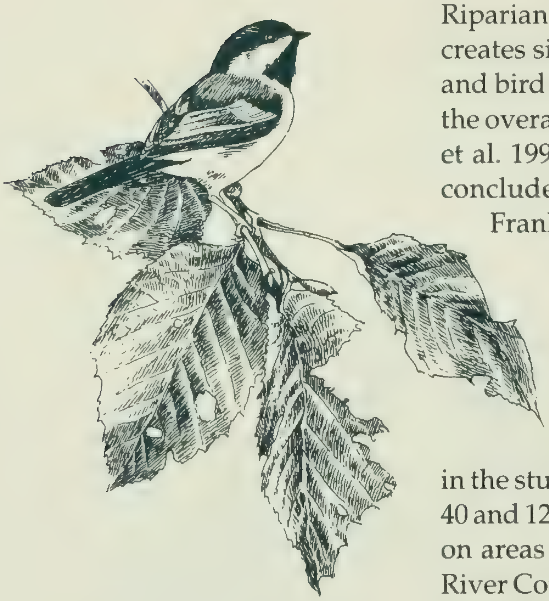
Most of the study area consists of upland and riparian forest communities, including conifer, mixed coniferous/hardwood, and hardwood. Upland grassland and deciduous shrub communities are sparsely distributed.

A riparian zone is defined as the river channel and lands where vegetation is influenced by elevated water tables, flooding, or by the ability of soils to hold water (Naiman et al. 1993). It is the zone of direct ecological interaction between the forest and the river system (Swanson and Franklin 1992).

The riparian zone is ecologically important for many reasons. Long-term studies have found consistently high levels of biological diversity in riparian zones. For example, more species of breeding birds use riparian areas than any other habitat type in North America, and studies in the Cascades have found up to twice the species richness in riparian zones in comparison to upland habitats (Douglas et al. 1992; Gregory et al. 1991).

Studies also have found that nearly 70% of vertebrate wildlife species in a region use riparian corridors in some significant way during their life cycles (Naiman et al. 1993). The Elwha riparian zone provides, or could provide, important habitat for threatened, endangered, or rare species including the northern spotted owl, bald eagle, bull trout, Pacific fisher, gray wolf, northern red-legged frog, Van Dyke's salamander, harlequin duck, and pileated woodpecker. Riparian zones often play an important role within landscapes as corridors for dispersal of plants (Gregory et al. 1991).

The riparian zone is a critical component of the overall hydrologic process of the Elwha River. In general, a natural riparian zone connects montane headwaters with lowland terrains, providing avenues for the transfer of water, nutrients, sediment, organic matter, and aquatic and terrestrial organisms (Gregory et al. 1991). A natural riparian zone reduces the severity of flood events, acts as a buffer to pollution sources entering the river, controls the loss of groundwater nutrients into the river, and provides important fish habitat and food sources from overhanging vegetation and associated terrestrial insects.



Riparian zone woody debris entering and accumulating in the river channel creates significant amounts of habitat for aquatic insect, fish, small mammal, and bird species, and influences the formation of pools, river movement, and the overall structural habitat diversity of the river system (USFS 1988; Gregory et al. 1991). Extensive research into the ecological role of woody debris has concluded that it is a critical element of river ecosystems (Swanson and Franklin 1992).

Upland Communities

In the study area, conifers, primarily Douglas-fir, comprise more than 75% of the trees in conifer forests and 25-75% of the mixed forests (table 20). Approximately 71% of the conifer and mixed forest in the study area is second growth on land that was logged or burned between 40 and 120 years ago. Second-growth stands around Lake Aldwell are primarily on areas that have been logged; nearly 70% of that land is owned by James River Corporation. Second-growth conifer and mixed stands make up 24-48% of the land in Krause Bottom, Sweets Bottom, and the vicinity of Lake Mills. Most of these second-growth stands have developed following numerous fires in the Elwha drainage since 1891 (Pickford et al. 1980).

No old-growth forest remains adjacent to Lake Aldwell; however, old-growth forests comprise between 14 and 36% of the study area in Sweets Bottom, Krause Bottom, and in the vicinity of Lake Mills. These stands are dominated by Douglas-fir and grand fir interspersed with smaller, subdominant western hemlock and a few bigleaf maple. In bottom lands such as Krause Bottom, the understory of old-growth and mature stands tends to be open, park-like, and dominated by grasses and forbs, indicating heavy use by Roosevelt elk. Similar stands on side slopes, such as those adjacent to Lake Mills, have a dense understory consisting of salal on drier sites and ferns on wetter sites.

Conifers comprise less than 25% of the trees in hardwood forests. Hardwood forests are usually dominated by red alder interspersed with bigleaf maple, black cottonwood, and willow. Mature hardwood stands occur mainly in the riparian corridor along the river, comprising 25% of the area within Sweets Bottom. Approximately 17% of the lands adjacent to Lake Aldwell support hardwood stands. Hardwood forests are found on 7% of the land in the vicinity of Lake Mills and in 10% of Krause Bottom. Further studies in 1994 (NPS 1994a) examined the more specific vegetative conditions at Krause Bottom.

Wetland Communities

Wetlands modulate river flows during storm events, stabilize banks and erosion, trap sediments, retain nutrients, provide wildlife habitat, and facilitate energy and nutrient flows (Brinson et al. 1981; Adamus and Stockwell 1983).

Wetlands, or palustrine vegetation, comprise approximately 8% of the study area. They include forest, scrub/shrub, and emergent types. Approximately

50% of the wetlands are in Sweets Bottom, although the largest stand of palustrine forest (27 acres) is located near Lake Aldwell. Many of the other wetlands are relatively small and are found in Krause Bottom and along creeks draining into the reservoirs. Willow and red alder are the dominant tree species in wetlands; common understory species include salmonberry, Indian plum, and skunk cabbage.

Wetland information was updated with an additional inventory in 1995 (Klein 1995). This inventory documented wetland locations, sizes, characteristics including plant communities, buffer conditions, ratings, existing disturbances, and wetland functions. Data from this inventory will be used to refine wetland impacts in the final environmental impact statement.

Nonvegetated Area

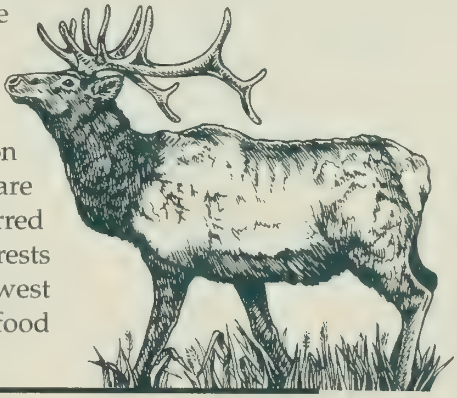
Approximately 10% of the study area is not vegetated — the river (6%), gravel bars (2%), barren areas (0.4%), and pavement or buildings (1%). Developed areas are primarily associated with project operations at Elwha and Glines Canyon dams. Over 12% of the area in Krause Bottom consists of gravel bars.

Wildlife

The Elwha area supports a variety of birds, large and small mammals, amphibians, and reptiles. One of the large mammals is Roosevelt elk; important elk calving areas are at the mouth of Cat Creek, at the upstream end of Lake Mills, and near Altaire campground just below Glines Canyon Dam (*Elwha Report*, p. 19). Small mammals include beaver, mink, river otter, and pine marten. Birds include numerous songbirds, waterfowl, raptors, and marine species. At least 22 species of wildlife feed in whole or in part on salmon or their carcasses, including black bear, bald eagle, mink, river otter, Pacific fisher, pine marten, long-tailed weasel, belted kingfisher, and common merganser (Cederholm et al. 1989).

Mammals

The Roosevelt elk is a common large mammal in the study area, although little is known about its local distribution, density, and movements in the Elwha drainage. On the west side of the peninsula, elk are primarily resident (approximately 60%); mean winter densities range from 15 per square mile for the Hoh to 19 per square mile for the Queets River areas (Houston et al. 1987; Houston et al. 1990). The entire west side elk population is estimated between 3,000 and 4,000 (Houston et al. 1990). Valley floors are preferred habitats in all seasons except winter; old-growth forests are preferred habitats in all seasons except spring, when grasses in earlier successional forests are emerging (Schroer 1988; Leslie et al. 1984). The elk population on the west side of the peninsula appears to be stable and at equilibrium with its food resource (Leslie et al. 1984).



In contrast, elk on the east side of the peninsula are migratory. They use low-elevation valley bottoms outside Olympic National Park during the winter and calving season (May to June). Riparian habitats provide migration corridors to the subalpine lands in the park, which are preferred summer habitat (Schroer 1986). Elk on the east side are much less abundant than on the west side and are declining. The current east side population is estimated at less than 250, with individual subpopulations numbering from 20 to 50 animals, or less than half of historic levels estimated for various river drainages. These migratory subpopulations are considered especially vulnerable to hunting, logging, and increasing human development on winter ranges adjoining the park (Houston et al. 1990).

Since the Elwha is between the east and west side drainages on the Olympic Peninsula, it probably supports both resident and migratory elk. The understory throughout much of Sweets Bottom is open and park-like, indicating intense browsing by elk.

Optimal winter habitat for elk includes a mixture of forage and nearby cover. In the study area, old-growth conifer stands are optimal habitat, providing thermal and hiding cover during severe cold as well as forage. Mature second-growth conifer stands mainly provide thermal cover. Primary forage cover types include mature second-growth hardwood and mixed forests, shrublands, grasslands, and palustrine wetlands. Winter forage for elk in the study area is believed to be the primary factor currently limiting their population.

Other large mammals in the Elwha drainage include black-tailed deer, black bear, and mountain lion. Numbers of black-tailed deer in the Glines Canyon and Elwha project area appear limited by the availability of winter forage. Black bear density in the national park appears relatively high, although no data on bear numbers are available. Black bear density along the Elwha may be lower than elsewhere in the park because of the lack of salmon carcasses that provide food for this species in other drainages (Cederholm et al. 1989). Mountain lions are considered relatively common in the project vicinity and several observations are typically reported each year. The area's primary predator, the grey wolf, has been extirpated on the peninsula.

A variety of smaller mammals occur in Olympic National Park but little is known of their distributions and densities. Raccoon, muskrat, mink, river otter, and beaver use the riparian, aquatic, and wetland habitats along the Elwha. The pine marten, which inhabits mature and old growth coniferous forests (Allen 1982), may be fairly common throughout the national park, and probably occurs in the study area. The Pacific fisher is rare and nearly extinct on the Olympic Peninsula (see Species of Special Concern section).

Habitat Evaluation Procedures applied to the Elwha and Glines Canyon project areas indicate that palustrine shrub wetlands provide optimal winter forage for beaver, while the long shoreline of the Elwha River provides nearly optimal habitat for mink. The Lake Aldwell shoreline also is relatively productive mink habitat (James River II 1988).

Approximately 15 other species of small- and medium-sized mammals, including shrews, bats, squirrels, hares, mice, rabbits, and skunks, are found in the Elwha drainage. This species group provides the major prey base for most terrestrial carnivores and many raptors in the study area.

Birds

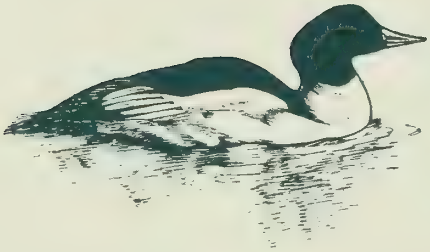
Up to 11 species of raptors (predatory birds) have been observed in the Elwha drainage, including the red-tailed hawk, northern pygmy owl, osprey, and sharp-shinned hawk (Sharpe 1990). The bald eagle, northern spotted owl, and northern goshawk are known to be in the study area and are addressed in the Species of Special Concern section.

Lake Aldwell, Lake Mills, and the Elwha River provide habitat for a wide variety of waterfowl. The common goldeneye, bufflehead, and lesser scaup are common winter residents on both reservoirs. Common mergansers, mallards, and harlequin ducks have been observed year-round on the lower and middle reaches of the river, and breed in the area (Sharpe 1990).

Lake Aldwell is used as early winter staging habitat (late November through December) by trumpeter swans (Jordan 1995). While the Pacific Coast population of trumpeter swans is neither threatened nor endangered, these birds are of local concern. The swans, also known to use Lake Mills, have recently numbered up to 80. Those that spend the entire winter in the Elwha/Port Angeles/Sequim area number approximately 20. The Pacific Coast population currently totals approximately 14,000 birds, with 2,000 wintering in western Washington. The swans use a variety of habitat types including agricultural fields, forested wetlands, ponds, lakes, and estuaries. Although this species was hunted to near extinction by the early 1930s, conservation efforts have slowly rebuilt populations. As a result, trumpeter swans have been increasing over the last 15 years (WDFW 1994b). In 1990-1992, sightings of trumpeters in winter index areas of the Pacific Coast region were already above year 2001 North American Waterfowl Management Plan goals of 10,000 birds.

Because of its proximity to the Strait of Juan de Fuca, the lower Elwha River, particularly the delta, provides foraging habitat for a variety of marine birds. Bald eagle, marbled murrelet, common loon, and harlequin duck are addressed in the section on species of special concern. Old-growth and mature conifer forests provide habitat for a variety of other species including the following species of special concern: northern spotted owl, northern goshawk, Vaux's swift, and pileated woodpecker.

Reptiles and Amphibians



Surveys in 1995 confirmed three species of reptiles and seven amphibians in the project vicinity: northern alligator lizard, common garter snake, northwestern garter snake, Olympic salamander, rough-skinned newt, ensatina, western red-backed salamander, tailed frog, northern red-legged frog, and Pacific tree frog. Other previously reported or suspected species include the rubber boa, Cope's giant salamander, northwestern salamander, and Van Dyke's salamander (Loafman et al. 1995).

Species of Special Concern

Four species federally listed as threatened inhabit the area — bald eagle, northern spotted owl, marbled murrelet, and Steller sea lion. One species federally listed as endangered, the peregrine falcon, occurs nearby. Species in the area that are currently candidates for federal listing are the Pacific fisher, harlequin duck, northern goshawk, northern red-legged frog, and bull trout.

Candidates for state listing are the pileated woodpecker, common loon, Van Dyke's salamander, Vaux's swift, and golden eagle. Four sensitive plant species occur in the area (FERC 1993, WDNR 1995, NPS 1995 unpub. rpt.): tall bugbane (*Cimicifuga elata*), giant helleborine (*Epipactis gigantea*), branching montia (*Montia diffusa*), and California hedge-parsley (*Yabea microcarpa*).

Federally Listed Species

Bald Eagle

Bald eagles, federally listed as threatened, have been observed year-round in the study area. No nests have been documented along the reservoirs or the river, presumably due to low prey availability and lack of perch and nest trees on private lands downstream of Elwha Dam due to logging. The Strait of Juan de Fuca from Port Angeles to Neah Bay is used by 30 to 35 nesting pairs; two of these sites are just east of the Elwha delta (WDFW Anita McMillan, pers. comm., September 1995).

James River Corporation conducted surveys of the study area from November 25, 1989, to April 14, 1990, that included both the wintering and early nesting periods of bald eagles (James River II 1990). The purpose of the surveys was to document eagle use of the mainstem of the Elwha River, associated tributaries, and coastal areas. Fourteen eagles were observed during the survey period. The survey results and discussions with regional biologists and local landowners indicate that eagle densities upriver decreased with distance from the delta, with very low numbers above Lake Mills. Significantly greater numbers of eagles were detected along the coast than anywhere along the river corridor.

Bald eagles in the study area feed primarily on high concentrations of glaucous-winged gulls and other marine birds along the coast, chinook salmon carcasses in the lower river section, non-anadromous fish stocks in the reservoirs, and carrion, including elk and heron carcasses. High prey availability along the coast in comparison with the middle and upper river sections may explain the observed patterns in eagle use within the study area. Salmon carcasses appear to constitute an essential food source for wintering and breeding populations located elsewhere in Washington (Stalmaster and Gessaman 1984). Similarly, low bald eagle use of the lower Elwha is probably related primarily to low numbers of chum salmon and late spawning coho and, to a lesser extent, to loss of potential roosts, perch sites, and nesting habitat due to logging.

Bald eagle.
(Janis Burger photo)

Northern Spotted Owl

The northern spotted owl, federally listed as threatened, typically inhabits unlogged old-growth forests or mixed forests of mature and old-growth timber (Forsman et al. 1984). Forests with old-growth characteristics occur throughout the Elwha drainage in the park, and the National Park Service has surveyed some of this habitat for spotted owls. Forests outside the national park, surrounding Lake Aldwell, have been surveyed by the US Forest Service and private firms.

Northern spotted owl surveys have found seven pairs between the Elwha headwaters and the national park boundary (FERC 1993), two active nests located within 2.2 miles of the river and Lake Mills, and at least one additional nest between US Highway 101 and Lake Aldwell, 1.2 miles from Elwha Dam. "Site center" and nesting locations frequently move small distances (generally less than 0.5 mile) from year to year, so that the precise distances from owl sites to the damsites will vary depending on the year.

National Park Service surveys in 1995 did not locate any additional owl nests, although one additional owl pair was located approximately 2.5 miles from Glines Canyon Dam. The area around Lake Aldwell has been thoroughly surveyed; it is unlikely that additional owl sites will be found (Erran Seaman, Biologist, National Biological Survey, Port Angeles, Washington, pers. comm., November 8, 1994).

Marbled Murrelet

The marbled murrelet, federally listed as threatened, has been observed flying in the Elwha valley and probably nests in the drainage. In western Washington, this species prefers to nest in old-growth or large sawtimber forest stands within 39 miles of the coast and below 3500 feet elevation (Brown 1985). Nesting season in Washington is between April 1 and September 15.

Sixty-seven surveys for murrelets were completed during the 1995 breeding season at 15 detection stations throughout the project area (Hathorn et al.

1995). A total of 145 murrelet detections (birds heard or seen) were recorded. Most (63%) were obtained at boat stations on Lake Mills (71 detections) and Lake Aldwell (21). Two detections on average were recorded per survey, with a range of 0 to 17. Observation patterns indicated low numbers of birds in daily north-south travel movements along the river. No evidence of nesting was found in the project area; the nearest activity appeared to be in upper parts of adjoining tributary streams such as Boulder Creek, or farther upriver, which is similar to earlier findings in earlier studies (FERC 1993).

Reconnaissance-level surveys were conducted in 1990 (James River II 1990). Eighty-eight surveys were conducted during this time — 55 at dawn and 33 at dusk. Along the river, 85 detections of marbled murrelets, one visual and 84 acoustical, were recorded. All detections were from dawn surveys at stations located within the park. Approximately 142 murrelet sightings, including some of groups of two and three individuals, were recorded along the river over the entire survey period.

Based on these surveys, the Elwha valley between Krause Bottom and the delta apparently serves as a flight corridor between the marine environment and nesting stands along the upper reaches of the Elwha valley or tributaries, where an estimated 15 pairs of marbled murrelets bred during the 1990 season. Murrelets calling and circling the canopy in stands along Boulder, Cat, Idaho, and Stukey creeks and above Altaire Campground may indicate nests.

A total of 1,018 marbled murrelets were observed from the marine survey stations. Distribution at sea appeared to be correlated with habitat complexity, such as the bays and/or mixed rock-sand substrates near Ediz Hook and Crescent Bay. Lower numbers of murrelets were observed in relatively featureless habitats, such as the Elwha delta. No murrelets were observed feeding or resting on either Lake Mills or Lake Aldwell in 1990. In August 1994, rafts of up to 14 birds were observed within 3 miles east or west of the river mouth; these observations were in shallow waters (less than 10 fathoms) and within one-half mile of shore.

The area potentially affected by dam removal was inspected by US Fish and Wildlife Service and Washington Department of Fish and Wildlife biologists in October 1994 to update presence of suitable habitat for marbled murrelet and identify stations for 1995 and 1996 surveys. Suitable habitat was identified in forests adjacent to Lake Mills, Glines Canyon Dam, Lake Aldwell, and the west side of the canyon below Elwha Dam. The habitat around Lake Aldwell is considered only marginally suitable. These areas are currently being surveyed for nesting, and will be resurveyed in 1996 to comply with requirements of the Endangered Species Act. If nesting birds are found in the project area, appropriate conservation measures will be identified to mitigate anticipated effects of dam removal (see Impacts section for Species of Special Concern for more detail).

US Forest Service and state lands in the vicinity of the Elwha River have been proposed as critical habitat for murrelets by the US Fish and Wildlife Service under the Endangered Species Act (60 Federal Register, p. 40892, August 10, 1995). A final ruling on the designation of critical habitat has not been made.

Steller Sea Lion

The Steller (northern) sea lion is federally listed as a threatened species. It is distributed from California to the Bering Sea, and is in Puget Sound and the Strait of Juan de Fuca primarily between September and March, although small numbers occur year-round in this area (Bonnell et al. 1992; Calambokidis and Baird 1994; T. Loughlin, pers. comm., Biologist, National Marine Mammal Laboratory, National Marine Fisheries Service, Seattle, Washington, March 22, 1995). The nearest haulout site (resting area on shore) is located at Race Rocks, British Columbia, approximately 12 miles north of the project area (Calambokidis and Baird 1994, Pat Gearin, pers. comm., Biologist, National Marine Mammal Laboratory, National Marine Fisheries Service, Seattle, Washington, March 23, 1995). No Steller sea lion breeding sites are known in Washington.

In Washington and British Columbia, Steller sea lions feed on octopus, squid, herring, hake, rockfish, halibut, and salmon, although salmon comprise only a few percent of their diet (Olesiuk and Bigg 1988). Some Steller sea lions travel up freshwater rivers, notably the Rogue River in Oregon, where they feed on lampreys and, occasionally, salmon parasitized by lampreys (Reeves et al. 1992). Most sea lions in the area are California sea lions which are not an endangered, threatened, or candidate species.

Peregrine Falcon

No known nesting occurs in the vicinity, the closest being along the outer coast and in the San Juan Islands (WDW 1991). Significant numbers of wintering peregrines near Sequim hunt marine shorebirds and waterfowl, and may use the coast near the mouth of the river.

Federal Candidate Species

Pacific Fisher

The status of the Pacific fisher is poorly known on the Olympic Peninsula and presumed to be rare (Aubrey and Houston 1992). Although the Elwha valley is considered good fisher habitat, particularly the riparian areas, the last reliable sighting of a fisher in the Elwha River drainage was in the study area in 1975, just outside the park boundary near Herrick Road. There is also a historic record from near river mile 22 (WDFW 1995a).

Harlequin Duck

Harlequin ducks typically breed in forests adjacent to swift-moving streams. During spring and summer they feed on invertebrates inhabiting the streams. Wintering harlequins feed on snails, limpets, crabs, and chitons in nearshore saltwater areas. Relatively large numbers of the ducks were found near the river mouth in recent winter surveys (WDFW 1994a). The Elwha River drainage, above and below the dams, is considered prime nesting habitat for the harlequin duck (Greg Schirato, pers. comm., WDFW, October 7, 1994). Two pairs are known to nest between Glines Canyon Dam and Lake Aldwell. Although often considered ground nesters, habitat surveys for harlequins conducted by the Washington Department of Fish and Wildlife in 1991 located one of only two known tree-cavity nests ever found in North America, approximately 10 miles upriver from Lake Mills near Elkhorn Ranger Station.

Northern Goshawk

The northern goshawk is a breeding resident in the project area and occasionally observed year-round. One pair is known to traditionally nest along the Whiskey Bend trail (Sharpe 1990; WDFW 1995a). The goshawk breeds in the dense canopy of mature conifer forests or mixed stands of conifers and deciduous trees. This accipiter preys on medium-sized mammals and birds, hunting from concealed perches or while flying. Foraging often occurs at the edges of forests; grouse are an important prey item (Verner and Boss 1980).

Northern Red-Legged Frog

Northern red-legged frogs occur in moist forests and riparian areas and are resident in ponds and streams throughout the national park. During non-breeding times, they can be found several hundred yards from water. Breeding habitat generally contains sturdy underwater stems, for egg attachment, and exhibits little or no flow (Nussbaum et al. 1983). Breeding starts with eggs deposited in February or as early as January. This species was found in the project area in 1995 surveys (Loafman et al. 1995).

Bull Trout

Although current and historic information on bull trout within the Elwha basin is very limited, they probably exhibited fluvial and resident life history patterns. Also, there may have been an anadromous population. The population above Glines Canyon Dam is considered to be healthy and at no immediate risk. Bull trout have been reported in the upper reaches in various studies since the mid-1950s. They also have been captured in the middle reaches between the dams indicating that adfluvial and fluvial populations are present. The middle reach population status is uncertain because of the lack of information. Few bull trout have been encountered in the lower reaches below Elwha Dam during recent studies (FWS 1995, *Draft Biological Opinion on Bull Trout of the Elwha River Drainage*). See the "Native Anadromous and

Resident Fisheries" section for additional information on bull trout and their habitat. Anadromous bull trout are one of 10 runs (referred to as native char) targeted for restoration in the proposed action.

Wildlife Species with State Status

Van Dyke's Salamander

Van Dyke's salamander inhabits seepages and streamside talus as well as talus slopes relatively distant from water (Nussbaum et al. 1983). This salamander was not found during 1995 surveys although it is suspected to occur in the area (Loafman et al. 1995).

Vaux's Swift

The Vaux's swift is a common summer breeding resident in the study area (Sharpe 1990). It uses tall (>40 feet), large snags for nesting, generally in mature and old-growth forests in riparian or upland areas (Brown 1985). Since this swift feeds on flying insects captured in mid-air over a variety of open habitats, its preferred habitat also includes forest clearings, lakes, and streams (Verner and Boss 1980).

Pileated Woodpecker

The pileated woodpecker also requires large trees and snags for reproduction, as well as for feeding (Schroeder 1983). In this area, they probably prefer Douglas-fir and deciduous riparian forests with two or more canopy layers (Bull and Snider 1993). These large woodpeckers excavate a new nest cavity each year; old cavities are used by numerous other species in the ecosystem including saw-whet and screech owls, Vaux's swifts, flickers, chickadees, flying and tree squirrels, wood rats, and bats. Habitat Evaluation Procedures applied to the Elwha and Glines Canyon project areas indicate that the old-growth and mature mixed and conifer stands in the affected area provide moderate quality habitat for the pileated woodpecker (James River II 1988, 1990).

Golden Eagle

Golden eagles in western Washington usually nest in large trees in mature or old-growth forests or in subalpine areas. They hunt primarily medium-sized mammals including snowshoe hare, marmot, and mountain beaver (*Aplodontia*) (WDW 1991; Clark 1987). Nesting in the state is rare, but probably occurs in the highest portions of the Elwha drainage. Golden eagles are not commonly observed in the project vicinity.

Common Loon

Loons are fish-eating diving birds found in winter on marine waters and possibly use the reservoirs at times to hunt for small fish. Nesting in Washington is reported from only limited sites in the Cascades or farther east;

no nesting occurs on the reservoirs (WDW 1991). Even if nesting were attempted on the reservoirs, it is unlikely that loons' aquatic nests would be successful given fluctuating water levels (NPS 1988b).

State Sensitive Plant Species

The following plant species, considered sensitive by the state, are vulnerable or declining, and could become endangered or threatened without active management. Tall bugbane (*Cimicifuga elata*) and branching montia (*Montia diffusa)* have been documented in the study area (NPS 1995 survey, unpublished report). Bugbane and montia generally grow in moist forests (Hitchcock and Cronquist 1973). Giant helleborine (*Epipactis gigantea*) is a nonshowy orchid that prefers streambanks, seeps, and lake margins. Surveys conducted in 1990 located helleborine between the road to Whiskey Bend and Glines Canyon Dam, although this population could not be relocated in the 1995 survey. California hedge-parsley (*Yabea microcarpa*), a plant of rock outcrops, was also located in 1995 near Glines Canyon Dam and downriver.

Other Rare Species

The National Marine Fisheries Service is currently conducting status reviews for chum, and chinook salmon and steelhead and searun cutthroat trout in Washington. Status reviews determine whether a species is warranted for listing. These reviews should be completed soon and may result in the protection of all or some of these fish stocks under the Endangered Species Act.

Living Marine Resources

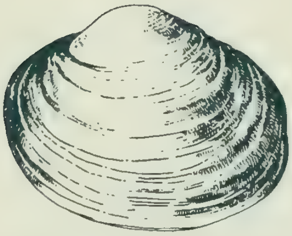
Nearshore marine environments, particularly near river mouths, are often critical habitats for a variety of plants and animals. For example, they support kelp "forests" that provide habitat for a variety of marine fish, and they are major initial rearing areas for anadromous fish, such as salmon. Intertidal areas (the shore between high and low tide) near river mouths often supply abundant numbers of hardshell clams, a major sport and commercial marine resource, possibly because of the suitable substrate. Subtidal areas (areas of water deeper than at low tide) contain a variety of plant and animal life because of varied food sources and substrate composition.

The nearshore marine community includes fish such as salmon, greenling, flatfish, rockfish, sculpins, clingfish, sand lance, herring; more than 50 species of marine algae (including kelp); birds, including gulls, common murres, marbled murrelets, rhinoceros auklets, and harlequin ducks; and mammals including the Pacific harbor seal and, infrequently, northern and California sea lions, orcas, and gray whales (Calambokidis et al. 1987, FWS 1995c). Nearshore substrates composed of boulders and cobbles support species that prefer rocky environments, such as kelp, many species of red algae, red and yellow sponges, red rock crab, barnacles, mussels, limpets, chitons, and periwinkles. Local kelp beds are particularly important as habitat for various species of baitfish, which are prey species for salmon, and recruitment and nursery habitats for juvenile marine fish including Pacific herring, rockfish, and lingcod.

Based on results of a survey in the summer of 1994, current marine resources near the Elwha River mouth are affected primarily by substrate, slope, depth, and wave action (FWS 1995c). The mid to upper portion of the intertidal zone near the river mouth consists of a steep beach with coarse substrate (e.g., cobbles and boulders) subject to high wave action. Farther from the river, eroding sea bluffs contribute a significant amount of sand and gravel to the intertidal beach. Because of these conditions, marine animal and plant life is relatively sparse. The primary animal found in the high intertidal was amphipods. The mid-intertidal contained a slightly greater variety of animals (e.g., limpets, barnacles, and mussels) and three types of marine plants including *Porphyra sp., Ulva sp.*, and *Acrosiphonia coalita*. The mid-intertidal farther from the river was sandy and supported animals such as cragon shrimp and sculpin.

The diversity and abundance of plants and animals were found to be highest from the lower intertidal out to a depth of approximately 50 feet where low light reduces plant growth. This area generally reflected the substrate composition of the intertidal zone but with an increase in the percentage of sand and gravel. Species abundance and diversity were highest closer to shore and out to a depth of approximately 25 feet, then decreased with an increase in depth. The lower intertidal and subtidal area nearest the river mouth contained the greatest abundance and variety of plants and animals within the survey area. This area supports a diverse and abundant community of plants and animals, including more than 30 species of macroalgae (brown, red, and green) with the more abundant species being *Alaria marginata, Cymathere triplicata, Pterygophora californica,* and *Nereocystis luetkeana*. Fish included salmon, herring, flatfish, greenling, rockfish, and perch. Generally, invertebrate abundance was low, but a variety of crabs (e.g., red rock, kelp, and decorator) and clams (littlenecks, butter, geoduck, and horse), other mollusks (rock scallops and barnacles) and starfish were present. Farther to the east and offshore of the eroding sea bluffs, the bottom contained more finer grained sediment (gravel and sand), a lower abundance of kelp or other algae (mostly green), and low abundance and diversity of fish and invertebrates. Dungeness and hermit crabs, flatfish, and geoduck clams were relatively more abundant where the substrate composition consisted of finer sediments.

Farther west of the river mouth in Freshwater Bay, the substrate is diverse. Areas of only sand, gravel, hardpan, boulders, and mixed course substrates were common. The coarser substrates, such as cobble, hardpan, and boulders, supported dense communities of kelp, including *Pterygophora californica, Nereocystis luetkeana, Laminaria saccharina,* and *Costaria costata.* Red algae, such as *Iridaea cordata* and *Botryogolossum farlowianum*, were present under the larger kelps. Sea urchins, sea cucumbers, and anemones were more abundant here than in any other area surveyed for the study. The vegetation in the sand substrate was sparse, except for the occurrence of diatoms, which formed a brown scum over large areas. *Ulva* sp. and *Zostera marina* were found at some locations. Macroinvertebrates observed in this area included Dungeness, decorator and hermit crabs, cragon shrimp, bivalves (including the basket cockle and horse and geoduck clams), the feather duster tube worm, several species of snails, and a yellow sponge. The fish most frequently encountered were flatfish, dogfish shark, and sculpins.



One of the most important habitats is the estuary. Sediment carried by the river is deposited offshore and eventually forms a bar that keeps salt water out during low tides; this creates a zone of brackish water where fresh and salt water mix. Many anadromous fish rely on estuaries to help them transition from a freshwater to marine environment. In addition, estuaries are among the most productive natural aquatic systems, and are important nursery areas that provide food, refuge from predators, and valuable habitat for a variety of freshwater and saltwater species. Juvenile chinook, pink, and chum salmon use estuaries for up to three months, feeding and growing at their most rapid rate before moving into the deeper marine water. Other salmonids also use estuarine habitat before moving into marine areas.

Valuable commercial species that depend on estuaries include crabs, shrimp, hardshell clams, oysters, and mussels. Juveniles of non-salmonid fish species, such as herring, anchovy, smelt, tomcod, lingcod, sculpin, and English sole, also need estuaries in which to feed and grow.

Shellfish are commonly pursued as a recreational resource in Washington in the intertidal areas, and are also commercially harvested from selected areas by Indian tribes and non-tribal commercial interests. Based on archeological evidence, tribal subsistence harvest of many species probably occurred in the past in the Freshwater Bay/lower Elwha and Ediz Hook areas (James 1993). Currently the most commonly pursued shellfish are hardshell clams, specifically littleneck, butter, and horse clams. Around the mouth of the Elwha, harvesting of these species is restricted by low abundance and recurring red tides or paralytic shellfish poison. This disease is caused by clams ingesting certain species of algae and the subsequent concentration of algal toxins. Because of persistence of this disease and the lack of routine testing in the area, the Washington Department of Fish and Wildlife annually closes all beaches west of Dungeness Spit to the taking of shellfish from April 1 to October 31.

Air Quality

Ambient air pollutant concentrations for the regions surrounding Olympic National Park are within national, state, and local air quality standards. This attainment status may be attributed to the low population density of non-urban areas and lack of many major, older industrial sources. Sulfur dioxide, nitrogen oxides, and suspended particulate matter are the air pollutants of principal concern from coal-fired power plants, refineries, and pulp and paper mills. High air pollutant concentrations in the Puget Sound lowlands region are associated with urban industrial and transportation sources. Rural areas experience occasional episodes of high suspended particulate matter resulting from windblown dust during high wind conditions, and are affected by agricultural operations, slash and field burning, occasional forest fires, and unpaved roads.

The US Environmental Protection Agency has set health-based standards for six air pollutants: ozone, oxides of nitrogen, fine particulate matter less than 10 micro meters in diameter (PM10), carbon monoxide, lead, and sulfur dioxide. When ambient concentrations of these pollutants exceed the standards, health problems can result. Clallam County and the project site are designated as attainment areas (i.e., concentrations below the standards) for all criteria pollutants. This designation is based on representative ambient air quality monitoring.

Concentrations of air pollutants in the study area (see table 21) are influenced by sources of emissions and the dispersion by weather patterns of the region. Major sources of air pollutants (greater than .907 metric tons or 100 tons per year) in Clallam County are the Daishowa America and Rayonier Inc mills. Silvicultural burns, dust and other particulate matter generated from vehicles on unpaved roads, vehicle exhaust, and smoke from campfires also affect the air quality in the middle and lower Elwha valley area and Olympic National Park.

The Prevention of Significant Deterioration (PSD) program is designed to allow growth in areas of good air quality without allowing pollutant concentrations to exceed the ambient air quality standards. Because of its unique nature, Olympic National Park has been designated a PSD Class I area. The Class I areas receive special air quality protection. To ensure that its air quality remains good, sulphur dioxide, ozone, and visibility are monitored within the park. Sulfur dioxide and ozone are pollutants of concern because these pollutants affect visibility and because many plant species in the park are sensitive to these pollutants. Clean offshore air flowing into the Olympic Peninsula maintains the near pristine air quality of the national park. However, the park is subjected to episodes of smoke and particulate matter pollution due to slash burning on adjacent lands and occasional forest fires. These short-term events affect visibility, but have limited impact on other park resources.

Table 21. *Air Quality Data and Standards for Olympic National Park (1994)*

POLLUTANT AND AVERAGING TIME PERIOD	NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)	HIGHEST 2ND-HIGH MONITORED CONCENTRATIONS IN OLYMPIC NP	HIGHEST 2ND-HIGH MONITORED CONCENTRATIONS NEAR OLYMPIC NP
SO_2 3-Hour[a] ($\mu g/m^3$)	1300	53	—
SO_2 24-Hour ($\mu g/m^3$)	365	19	—
SO_2 Annual ($\mu g/m^3$)	90	5.9	—
NO_2 Annual ($\mu g/m^3$)	100	—	28
O_3 1-Hour[b] (ppm)	.12	0.067	—
PM_{10} 24-Hour ($\mu g/m^3$)	150	—	28
PM_{10} Annual ($\mu g/m^3$)	50	—	13.9
CO 1-Hour (ppm)	35	—	5.8
CO 8-Hour (ppm)	9	—	3.8

[a] micrograms per cubic meter ($\mu g/m^3$)
[b] parts per million (ppm)

Noise

The study area and the surrounding region are now relatively quiet, with few sources of noise. Potential sources of noise in the Elwha valley near the dams include uses of popular recreation areas for scenic driving, hiking, motorized and non-motorized boating, fishing, camping, picnicking, and similar activities. Vehicles access Lake Aldwell via Highway 101, a major peninsula transportation route. Vehicles access Lake Mills by Olympic Hot Springs and Whiskey Bend roads. Boat access to the lakes is provided by ramps.

The area around Lake Aldwell, in the lower Elwha River valley and outside the boundaries of Olympic National Park, supports residential, logging, and agricultural activities (see section on Land Use for additional information). Lake Mills, in the upper Elwha valley, is within the national park and largely surrounded by congressionally designated wilderness. Natural sound levels at Aldwell and Mills are affected by occasional aircraft overflights, traffic on Olympic Hot Springs and Whiskey Bend roads, vehicles on roads near the lakes, and motor boats on the lakes. Noise levels are generally magnified on Lake Mills due to the very steep canyon in which it is situated.

Both Elwha and Glines Canyons dams are used for hydroelectric production. Production equipment includes switching gear, powerhouse, penstock, turbines, gated spillways, and high voltage transmission lines. This equipment is also a minor source of noise; turbine whine, high voltage electrical transmission line hum, and intermittent spills of water splashing through the spillways all contribute to unnatural sound levels.

Cultural Resources

The Elwha River valley is rich in cultural resources that include buildings, structures, landscapes, traditional cultural properties and other ethnographic resources, and archeological sites. These resources represent a long, continuous human occupation and demonstrate the importance of the Elwha River, which provides sustenance to the valley's inhabitants and serves as a transportation corridor into the heart of the Olympic Peninsula.

The Elwha River valley is the homeland of the Elwha Klallam people. European maritime exploration of the Olympic Peninsula began in the late 1700s. Settlement in the lower Elwha valley by Euro-Americans began in the 1860s with attempts at farming, and in the 1880s and 1890s reached the upper valley. Efforts to develop the area and exploit the bountiful resources — farming, logging, mining, transportation, public and private recreation and hydroelectricity — were an important part of the closing decades of the 19th and early 20th centuries. With the establishment of the Olympic Forest Reserve in l897 and, subsequently, Olympic National Monument in 1909 and Olympic National Park in 1938, there has been a continuous federal presence in the Elwha valley. This federal presence was intensified during World War I, and in the federal work relief efforts and wartime activities of the 1930s and 1940s.

Elwha Klallam People

The Elwha River is central to the culture of the Elwha Klallam people who, as demonstrated by archeological evidence and oral tradition, were living along the Elwha River, on the shores of Freshwater Bay and at the base of Ediz Hook long before the arrival of Euro-Americans. Elwha Klallam villages were located adjacent to important fishing stations at Ediz Hook, the mouth of the Elwha River, and at the confluence of Indian Creek and the Elwha River in the Elwha valley. Seasonal camps for fishing and other subsistence activities were located along the Elwha River and its tributaries and along the shores of Freshwater Bay and Ediz Hook (see figure 11). Smokehouses have been reported at Indian Creek, Little River, and in the vicinity of Boulder Creek. The Elwha Klallam people still lived at the confluence of Indian Creek and the Elwha River when construction of the Elwha Dam began in 1910, and Elwha Klallam occupied Ediz Hook into the 1940s.

The Elwha Klallam hunted for elk, deer, and other game and gathered berries, roots, and plant materials along the bottom lands of the Elwha and in the backcountry mountain meadows and headwaters of the river. Traditionally, they traveled along trails that followed the river and its tributaries into the high country of the Olympic Mountains. The Elwha Klallam sometimes met with different tribes, including other Klallam, Quinault, and Skokomish during hunting and berry picking expeditions into the mountains.

In 1854-55, the United States entered into land cession treaties with native tribes and bands in Washington Territory. The

Elwha Klallam were party to the Treaty of Point No Point signed in January 1855. Under the terms of the treaty, they retained the right to fish at their "usual and accustomed" fishing places, but they were not provided with reserved lands proximity to those fisheries. Instead, they were expected to live on the Skokomish River at the south end of the Hood Canal, an arrangement they found unworkable and unacceptable. They remained in their own territory while successive Indian Department officers urged the necessity of providing a reservation for the Elwha Klallam within their own homeland. The United States eventually purchased lands in the lower Elwha valley for this purpose in 1936-37, although the lands were not given formal status as an Indian Reservation until 1968.

Euro-Americans began to settle in the lower Elwha valley in the 1860s on land which the Indian people had occupied for centuries. Settlers could acquire land from the United States under federal laws if they were native-born American citizens, or if they declared their intent to become citizens. The Elwha Klallam, like most other Indians in the United States at that time, were not deemed to be citizens, and not being foreigners, could not become naturalized citizens. The Elwha Klallam were the only people in the Elwha valley who could not acquire land from the United States in their own homeland. With the assistance of Euro-American homesteaders and passage of an effective Indian homestead law in 1884, the Elwha Klallam were finally able to acquire legal title from the United States for their homesteads. By 1894, Elwha Klallam families had received trust patents to land amounting to about 1300 acres in the lowlands of the Elwha valley and on Freshwater Bay. The Indian homesteaders cleared lands, engaged in farming and stock raising, planted orchards, and raised crops and animals for sale to merchants and others in Port Angeles and the surrounding region.

Although the Elwha Klallam engaged in farming and other pursuits, they continued traditional activities such as hunting and fishing. Until the Elwha Dam prevented anadromous fish from reaching all but the first few miles of the river, the Elwha River fisheries remained the mainstay of their economy. The variety of methods they developed to harvest salmon and steelhead, including weirs, traps, nets, gaffing, spearing, gill nets and trolling, attest to the integral role the fish played in tribal life. As long as they had access to their traditional fisheries, the Elwha Klallam people remained self-supporting.

The river provided not only the resources for sustenance and lifeways of the Elwha Klallam, but was at the heart of their ceremonial, cultural, and spiritual existence. Construction of Glines and Elwha dams and the subsequent loss of the Elwha as a free flowing river cut at the core of their culture, destroying the fish vital to ceremony as well as economy. The dams decimated fish runs critical to their livelihoods and flooded villages, fish camps, homesteads, medicinal plant and food gathering and preparation sites, and, most likely, burial sites.

Some of their most important spiritual sites were (and still are) rendered inaccessible by the dams and/or reservoirs. The Elwha Klallam believe that the Creator made the Elwha Klallam people in the lower canyon of the Elwha River. In the place where their ancestors were created, they went to receive spiritual guidance and information about their future life. The creation site was buried by the Elwha Dam and Lake Aldwell.

Euro-American People

Although maritime explorers sailed along the Strait of Juan de Fuca as early as the late 1700s, Euro-Americans did not explore the Elwha River valley until the latter part of the nineteenth century. A number of parties (the first led by Lieutenant Joseph P. O'Neil in 1885) passed through the valley while exploring the largely unmapped interior of the peninsula and found evidence of hunters and a cabin, but no evidence of Euro-American settlers.

By the end of the nineteenth century, however, a number of Euro-Americans, drawn by the river and the area's resources, were homesteading in the valley. By the late 1880s, Henry and Jake Hansen were living in the upper Elwha valley, later moving to land near the confluence of the Elwha River and Indian Creek. Many others were soon trying to earn their living on small homesteads.

Cedar trees in the Elwha valley, Washington, no date. (Clallam County Historical Society)

Conditions on the Olympic Peninsula such as dense vegetation, and a climate that restricts crop selection and shortens the growing season has limited the potential of homesteading. Farming never went much beyond subsistence; those who managed to stay had to find other sources of income. They, as well as others, tried mining, logging, or providing for tourists who began to travel to the peninsula. Opportunities for mining, logging, and other development in the area eventually declined on lands set aside for the Olympic Forest Reserve in 1897, the Mount Olympus National Monument in 1909 and Olympic National Park in 1938.

In 1890, Thomas T. Aldwell moved from Canada, by way of Seattle and Port Townsend, to Port Angeles. In 1894, Aldwell recognized the potential for a power site on a claim he had purchased on the Elwha River and began acquiring lands necessary to build a hydroelectric dam and reservoir. In 1910, Aldwell and George A. Glines formed the Olympic Power and Development Company to build a dam and power plant. Backed by eastern financiers, construction got underway that same year. Although the Elwha Dam's original foundation failed in 1912, the dam and power plant were completed in 1914. From 1926 to 1927, a second dam and power plant were constructed at Glines Canyon, 8.5 miles upriver from the Elwha Dam. Despite state laws requiring fish passage, neither dam included such measures.

The dams provided a reliable source of power not only to Port Angeles, but also to mills and military facilities in Bremerton, Port Townsend and other peninsula communities. Under the marketing efforts of the Olympic Power Company, and later the Northwestern Power and Light Company, the Elwha Dam led to the establishment of the long distance transmission lines on the peninsula assuring a greater degree of economic stability for the region. For some members of the Port Angeles community, the dams became part of their history because family members worked on the construction or lived in the valley during construction.

Construction of the dams resulted in radical changes in the character of the valley and the river. Although the hydroelectric developments were an important source of electricity for the Olympic Peninsula, the reservoirs inundated spiritual sites and homes, and the dams blocked native fish runs of the Elwha river and its tributaries. Elwha Klallam and non-Indian residents suffered further losses when the Elwha Dam failed during construction in 1912. A primary bridge crossing over the Elwha was washed away and a mill was damaged. In one case, all of an Indian homesteader's property was swept away by the resulting flood. Other homesteaders had topsoil washed away and and farm fields were covered with debris. The dams transformed the lives of people who lived near and depended on the river.

Affected Resources

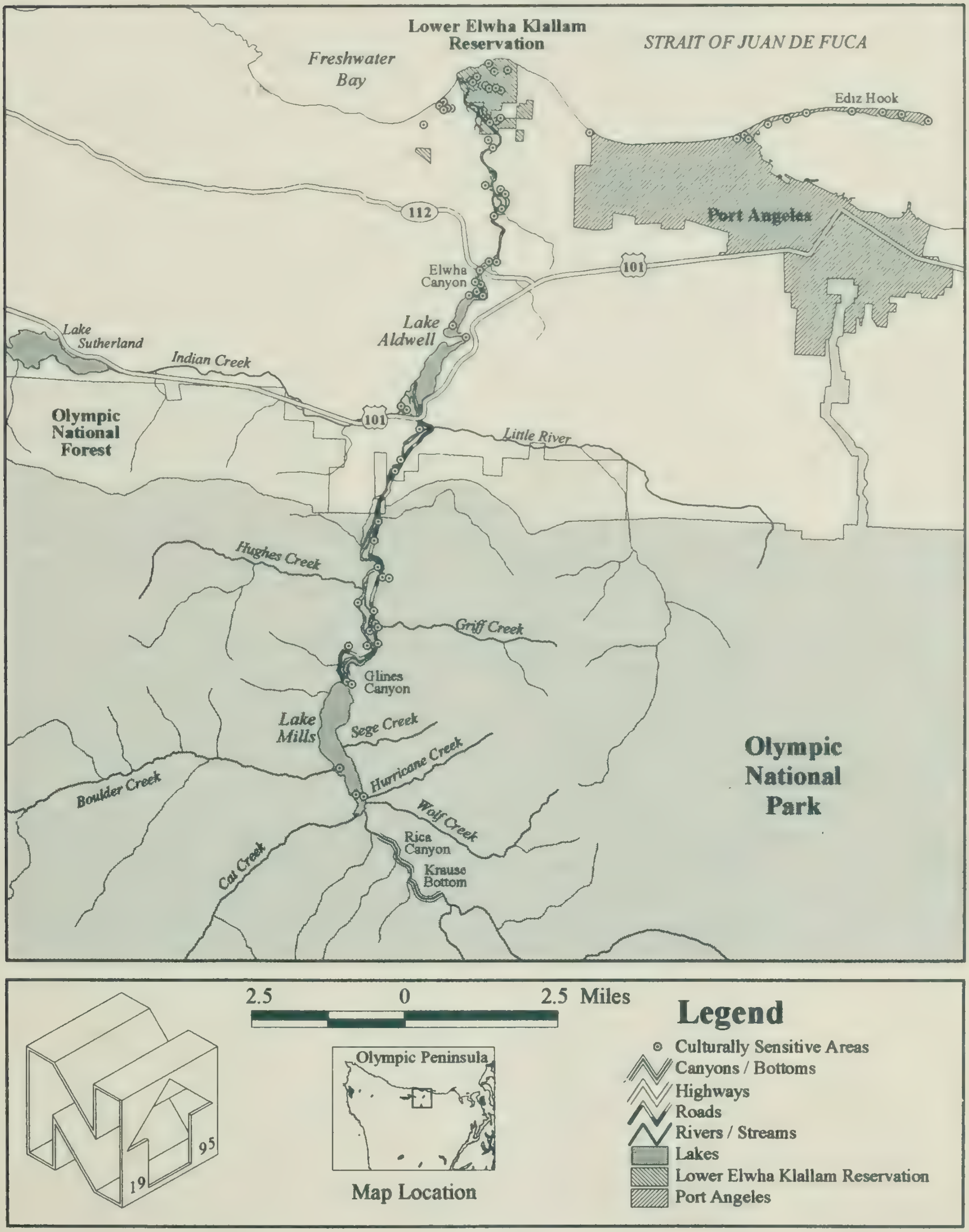
Elwha and Glines Canyon dams, hydropower plants, and associated facilities are now included in the National Register of Historic Places, a source of pride to many local residents. The projects are considered historically significant

Figure 11. *Cultural Sites*

Olympic National Park

United States Department of the Interior - National Park Service

DSC - December 1995 - 149 - 20072



for their associations with the rapidly evolving technology of power generation and the organizations that formed to develop and distribute power. In addition, the Elwha River plant is an example of a low head hydroelectric system and a rare, early example of the multiple-buttress type dam. The Elwha River Hydroelectric Power Plant Historic District encompasses the dam and both spillways, the five penstocks, and powerhouse. Glines Canyon Hydroelectric Historic District includes the dam and spillway, intake, powerhouse, gate house, and surge tank. On-going research suggests that the dams are part of a larger cultural landscape that comprises the reservoir and river course extending from Glines Canyon Dam to the Elwha Dam, including Olympic Hot Springs Road.

Significant resources located in the project area reflect the role of the federal government in the Elwha River valley. The Elwha Ranger Station, built by the Forest Service in the 1930s, is the most complete and unaltered example of Forest Service architecture in Olympic National Park and possibly on the Olympic Peninsula. Community kitchens constructed by the Civilian Conservation Corps are found at Altaire and Elwha campgrounds. The one-lane Elwha River bridge, one of the earliest Warren Truss bridges in the state, is included in the National Register of Historic Places as an important representation of transportation development in the valley.

Historical research indicates that there were 10 Elwha Klallam and approximately 30 Euro-American homesteads along the Elwha River. Some of the 30 Euro-American homesteads were unable to persist for more than a few years. Archeological surveys have documented one Elwha Klallam homestead (Hunter John) and two Euro-American (Smith homestead and Bowman Cabin). The site of the Waumila Lodge resort and cabins represents an early commercial recreational development while the site of the former cabin, berry farm, and resort of Lester and Anna Sweet is an example of the early settlers' diversification to survive. Other sites include the remains of the Milwaukee Railroad (later Spruce Production Division Railroad) that provide evidence of logging during and after the First World War. The survey also revealed the presence of stripped cedar trees (bark stripped from cedar trees is used for Klallam traditional activities), an historic artifact scatter, and a cabin site thought to date from the period of nineteenth century exploration. Located near the one-lane bridge are the Rayonier intake/screen house and water system remaining from a mill that played a significant role in the development of the timber industry in the Elwha valley.

Socioeconomics

Clallam County encompasses an area from just east of the city of Sequim westward along the Strait of Juan de Fuca to the most westerly point of land in the continental United States, Cape Flattery, and south to include the town of Forks (see figure 1). Port Angeles is the largest city in the county. The county also contains a major portion of Olympic National Park. Four treaty tribes, the Elwha Klallam, the Jamestown S'Klallam, the Makah, and the Quileute, have reservation lands in Clallam County.

Clallam County's population was 56,464 in 1990, an increase of 9% from 1980. Caucasians make up 93% of the population, with 2,695 Native Americans representing the largest county racial minority. An estimated 556 Native Americans resided on or near the Lower Elwha Klallam Reservation in 1990. The total county population is projected to reach about 63,000 by the year 2000, and 71,000 by 2010 (White et al. 1992).

Most of the county's population is concentrated around Port Angeles and Sequim. Port Angeles continues to be the population center of the county, accounting for over 32% of the total. Factors that contribute to this concentration include industrial, recreational, and tourism activity associated with Port Angeles deep water harbor; the "rain shadow" which makes the climate in the east end of the county more attractive; and land ownership patterns which put most of the south and west areas of the county in large commercial timber holdings and in Olympic National Park.

County Economic Base

For most of this century, the economy of Clallam County has been dominated by its natural resources and the attraction of its environmental amenities. The large timber resource base has made the timber industry a traditional economic mainstay; approximately 56% of the county's 1.13 million acre land base was managed for this purpose in 1992 (White et al. 1992). Over the past two decades, forest-based productivity in northwestern Washington State has declined, first, in the processing sector due to anticipated timber supply shortfalls and, more recently, in the harvest sector. The decline is primarily due to supply shortfalls, restrictions on exporting raw logs, and environmental concerns (Haynes 1990).

Commercial fishing and shellfish harvesting have also been important traditional activities for the county. Like the timber industry, activity in this

Off-loading logs from a truck to a ship for export, Port Angeles, Washington. (Janis Burger photo) sector has declined in recent years, principally due to declining numbers of fish. Other resource-based industries of importance include agriculture and mining.

A growing tourism industry serves the many visitors drawn to the county by Olympic National Park, ferry access to Victoria, British Columbia, salmon fishing, and opportunities to enjoy the varied scenic and recreational amenities in this area. More recently, the county's growing retirement community has created employment gains in the service sector of the economy (White et al. 1992).

Income, Employment, and Poverty

At the 1990 census, Clallam County per capita income was estimated at $12,755, and county unemployment stood at 8%. Median household income increased from $16,890 in 1980 to $25,434 in 1990. Consistent with national trends, earned income from employment in the county has declined from 59% to 50% of all income, 1980 to 1988.

County employment was estimated at 23,310 persons out of a potential workforce of 25,500 in May 1992. (White et al. 1992) The highest growth in employment between 1985 and 1990 was in government, retail/wholesale, and the construction sectors. Clallam County has lagged behind the state in employment growth, but has exceeded the state in retail/wholesale and government sectors.

Tourism, the growth in the size of the older population, and establishment of a new state corrections center at Clallam Bay have been significant contributors to the local economy. Major employers in the county, as of 1992, are listed in table 22.

Poverty levels in Clallam County were almost 2% higher than for Washington State as a whole at the 1990 Census. Members of the Lower Elwha Klallam Tribe are in a far more adverse position than county residents in general with respect to all economic indicators discussed in this section. Comparative 1990 census data for Washington, Clallam County, and the Lower Elwha Klallam Tribe for income, unemployment, and poverty are presented in table 23.

Public Infrastructure, Services, and Utilities

The government of Clallam County operated on a 1993 budget of $14.8 million (Gerdon 1994). Of this amount, $4.3 million came from property taxes and $2.1 million was generated from sales tax payments to the county's general fund. The county's combined state and local tax rate is 7.9%. The state retail sales and use tax portion is 6.5%; the county's sales and use tax portion equals 1.4%, and provides revenue to the county general fund (1.0%), the transit system (0.3%), and the criminal justice system (0.1%). An optional tax of 2% on occupancy of hotel/motel rooms is also received. This tax is not additive with state/local sales tax, but is credited against the state's 6.5% portion of

Table 22. *Major Employers in Clallam County*

EMPLOYER	PERSONS
Olympic Memorial Hospital	546
Port Angeles School District	502
Rayonier	434
U.S. Coast Guard	400
Clallam County	345
Daishowa America	320
Clallam Bay Correction Center	317
Sequim School District	247
Quillayute School District	202
City of Port Angeles	197
Peninsula College	180
K-Ply	130
Olympic National Park	130

SOURCE: White et al. 1992

Table 23. *Comparative Statistics on Economic Status*

	LOWER ELWHA KLALLAM TRIBE	CLALLAM COUNTY	WASHINGTON STATE
Per Capita Income	$5,000	$ 12,755	$14,923
Percent in Poverty	35%	9.5%	7.8%
Percent Unemployed	35%	8.0%	5.7%

Note: These data underestimate tribal unemployment for some months when the unemployment rate may rise as high as 80% (FERC 1993, p. 3-99)

SOURCE: 1990 Census

those taxes. The 1994 property tax from structures associated with Glines Canyon Dam was $116,000. The 1994 property tax on structures at Elwha Dam was $114,000 (Gerdon 1994).

Water is supplied by Clallam County Public Utility District #1, the cities of Port Angeles, Sequim, and Forks, and by private irrigation districts, water associations, and community well systems. Port Angeles's water supply is drawn from the lower Elwha Ranney well. Five reservoirs, situated around the city, receive water through 24-inch pipelines along the old railroad grade. The storage capacity of the existing reservoirs is 11 million gallons. More than 7,000 customers use 4 million gallons per day (White et al. 1992). Dry Creek

Water Association wells, which supply a small group of rural users, are located adjacent to the lower Elwha River.

Port Angeles deep water harbor is protected from storms by Ediz Hook, a natural sand barrier that encircles the harbor from west to east. Ediz Hook was formed with material eroded from adjacent sea bluffs and from Elwha River sediment deposition. Over the years, construction of dams on the Elwha and erosion control measures on the sea bluffs have substantially reduced natural recruitment of material to Ediz Hook; consequently, today, the hook loses more material to wind and wave action than it receives. As a result, in 1978, the U.S. Army Corps of Engineers installed a rock-based blanket to reduce erosion of Ediz Hook at a cost of $5.6 million. Repair and maintenance costs approaching $100,000 per year are expected to control further erosion.

The 1990 census showed 25,225 housing units in Clallam County, an increase of 15% from 1980. Of these units, 17,479 were single family homes. Average household size in the county has declined from 2.54 persons in 1980 to 2.4 persons in 1990. A 1991 study by the Clallam County assessor estimated that 20% of county housing stock is in poor to fair condition. Sixty-four percent of housing units in the county are owner occupied, 27% rented, and 9% are vacant. Between 1980 and 1990, there was an 18% increase in homeless households and a 28% increase in homeless individuals in Clallam County (White et al. 1992).

The Lower Elwha Klallam Tribe has a total of 80 housing units available to tribal families; there are 87 additional families on the tribal housing waiting list. Average tribal household size is reported to be 3.7 persons. Only two of the families presently occupying tribal housing do not require housing subsidies because they earn sufficient income (Lower Elwha Klallam Tribe staff data 1994).

Electric Power Production

Electric power in the county is generally provided by Bonneville Power Administration via two local utilities, Clallam County Public Utility District #1 and Port Angeles City Light. Port Angeles City Light assesses an 11% overhead charge on Bonneville power provided through their system (FERC 1993, page 2-42).

Elwha and Glines Canyon Dams annually produce an average of 172 gigawatt-hours of power, or about 38% of the total for the Daishowa mill. The Daishowa mill currently employs approximately 320 persons (table 22). Operating and maintaining Elwha and Glines Canyon Dams employs approximately 10 people.

The estimated 1996 cost of power production from Elwha and Glines Canyon Dams, without any improvement expenses, is 12.29 mills (FERC 1993 pp. 2-38 to 2-39). The estimated real priority firm power rate, or the rate the Daishowa mill would actually pay for additional purchased power, for Bonneville customers in 1996 is 26.7 mills (BPA 1993). This real rate is expected to decline to 23 mills by 2001, and to remain near that cost level for the foreseeable future. As of 1995, Bonneville Power Administration regional avoided cost is at or below its average preferred rate (BPA 1995).

Fisheries and Fish Processing

Commercial and recreational fishing have been a cornerstone of the Clallam County economy. Construction of Elwha Dam in 1910 preempted fish resources secured to the Elwha Klallam, Port Gamble S'Klallam, Jamestown S'Klallam, and Makah tribes by treaty in 1855, initiating a substantial decline in Elwha River fish stocks (FERC 1993 page 3-101). More recently, reduced commercial and sport fisheries have continued in the Strait of Juan de Fuca, but with only low-level contributions from Elwha River hatchery-supported stocks (FERC 1993 page 3-103). The Federal Energy Regulatory Commission estimated fishery catches from Elwha stocks for the period 1990-1991 (FERC 1993 page

Table 24. *Estimated Annual Economic Value of Elwha Salmon and Steelhead*

TYPE OF CATCH	CATCH IN FISH (thousands)	FISH SIZE[a] (pounds)	CATCH IN POUNDS (thousands)	NET ECONOMIC VALUE MARKET (NONMARKET) (thousands of dollars)
Commercial & Tribal Chinook	5.5	11.5	63.2	175[b] (180[d])
Sport Chinook	2.8			73[c]
Commercial & Tribal Coho	19.3	6.5	125.4	292[e]
Sport Coho	2.6			68[c] (167[d])
Tribal Steelhead	1.8	7.0	12.6	46[f]
Sport Steelhead	1.8			47[c] (116[d])
Totals	**33.8**			**701 (463)**

[a] From FERC (1993), p. 3-103.

[b] Based on 1988-1990 average ex-vessel price of $1.85/lb., +52% increment for processor marginal net economic value.

[c] Based on marginal net economic value of $26.22 per fish, -50% gross sport angler expenditure per fish.

[d] Based on 1988-1990 nonmarket surplus of $64.31 per fish.

[e] Based on 1988-1990 average ex-vessel price of $1.53/lb., +52%increment of processor marginal net economic value.

[f] 1988-1990 sockeye ex-vessel proxy value of $2.43/lb., +52% increment for processor marginal net economic value.

Prices used in this table are based on data from the Washington Department of Fish and Wildlife and the Pacific Marine Fisheries Commission. Fishery net economic value conventions and nonmarket values are from Bonneville Power Administration (1986).

Sport fishing expenditure data are derived from The Research Group (1991).

Start of construction at the base of the Elwha Dam, 1911. (Daishowa/James River Company photo)

3-103); estimates of net economic value associated with these catches are presented in table 24.

The economic figures in table 24 do not include tribal subsistence fishing, nor do they incorporate tribal ceremonial or cultural values of Elwha fisheries.

Finally, it should be noted that fish harvests have declined substantially from the 1990-1991 conditions underlying table 24 with attendant major losses for Clallam County residents (Brown and Hodges 1994). Commercial fishing businesses in this area (and others) received federal disaster relief in 1994 when a large area of the Pacific coast was entirely closed to salmon fishing. Large-scale restrictions on salmon fishing were in effect in 1995 as well.

Recreation/Tourism

Recreation and tourism play a major economic role for Clallam County and the Elwha River drainage. Existing (1993) annual jobs and annual payroll in the travel and tourism sector are approximately 2,000 jobs generating $21.3 million. Clallam County tax receipts from this sector were estimated at $1.4 million in 1993. These figures are expected to increase slowly over the longer term. Travel and tourism expenditures in Clallam County in 1993 amounted to $116.9 million. Related payroll income was $18.8 million (Runyon 1994).

Principal visitor attractions are Olympic National Park, saltwater sport fishing in the adjacent ocean, and tourism travel to Olympic Peninsula sites and to Victoria, Canada. More than 4,000 accommodation units are available within the county, from hotels, motels, and campgrounds and this sector of the Clallam County economy is expecting significant growth over future years (White et al. 1992).

Social Values

Clallam County

Clallam County is in transition. Rural in nature, timber and fish dependent for most of its history, the county is now experiencing declines in its traditional resource-based activities, particularly in the Port Angeles to Forks Highway 101 corridor. In addition, the county is experiencing fairly rapid change due to increases in tourism, retirement settlement, and service-based jobs, notably from its eastern boundary at Sequim westward to the city of Port Angeles. A recent analysis points out that, with such changes, rural populations may be placed at risk due to limited structural diversity, a feeling of vulnerability to economic and political forces over which they exert little control, periods of inmigration and outmigration that may contribute to a population with limited attachment to local community and a draining of persons capable of enriching the community (FEMAT 1993).

The controversy and uncertainty concerning the fate of the two Elwha River hydroelectric projects contribute to the changing social values of Clallam County and the region. Since their construction, the projects have been a source of controversy, community pride for some, and most recently, national scrutiny.

The Olympic Power and Development Company, with financial backing from a Chicago investment firm and several Seattle businessmen drew public support for construction of the Elwha Dam. This dam, and the later-built Glines Canyon Dam, were viewed by some as representing progress, security, and new economic opportunities. Construction began on the Elwha Dam in 1910; however public controversy concerning the fate of the native salmon began to grow and with the construction of Glines Canyon Dam, the northern Peninsula became even less united and more uncertain about the trade-offs between hydropower and the free-flowing Elwha (Hawkins Hoffman 1992).

The complexity of the issues concerning restoring the Elwha River ecosystem is compounded by the social and economic circumstances of the Lower Elwha Klallam Tribe (see Tribal Circumstances above). The Tribe considers restoration of the Elwha River as an essential means of support to sustain their culture in the future.

Lower Elwha Klallam Tribe

The Elwha Klallam people played a substantial role in the area's early economy: homesteading in the late 1800s, selling produce to residents, and working in the lumber camps and mills in the early 1900s.

In 1910, construction on Elwha Dam began. Although this structure, and the one that followed at Glines Canyon in 1926, provided electricity for milling forest products at Port Angeles, it also preempted the greatest part of the salmon resource secured to the Elwha Klallam by the Treaty of Point No Point and severely affected the tribe's social and economic well-being. Preemption by Elwha and Glines Canyon Dams of the treaty fisheries secured to the tribe has combined with an almost total lack of effective access to alternative economic opportunity to leave the Lower Elwha Klallam Tribe today as relatively economically disadvantaged (table 23).

Tribal social circumstances have paralleled economic difficulties. Tribal society exhibits significant social support for its members, particularly on reservations and through extended families; however, Bachtold (1982), specifically referencing the Lower Elwha Klallam and other northwest tribes, reports strong linkages between economic well-being, health, and self-worth and concludes that continuing economic deprivation creates overwhelming stress among tribal members.

Fishing in Dungeness Bay. (Janis Burger photo)

Despite these difficulties, and the currently depressed level of fish harvests, Elwha fisheries continue to play a central role in tribal economic activity, culture and ceremony, and to offer hope for their improved future. This is perhaps best expressed by tribal chairperson Frances Charles:

> *I hate to think of the future, especially for our children, if our resources aren't there — the fish, the nature, the wildlife, the plants — which have always been provided for us. Our ancestors were raised to protect the river. They raised us to protect the river. We must be even stronger in the future — protecting what was given to us for our children, and for our children's children — and valuing what we have.*

The tribe continues to operate a fish hatchery for chinook, coho, and steelhead on the lower Elwha that released 71,500 pounds of juvenile salmon in 1995. The tribe considers the fishery potential of the Elwha River its most significant economic asset. Most tribal fishers presently rely on the river's fisheries to some degree to obtain a relatively small amount of income and/or food each year.

Nonmarket Values

Economic markets do not capture the full range of values associated with natural amenities in the Elwha River drainage, Clallam County, and more generally, the Olympic Peninsula. Economists describe such benefits as *nonmarket values* and measure them by estimating what "people would pay" over and above any costs they actually incur, to access the natural amenity for example, to visit Olympic National Park or to know the amenity is being preserved. Such natural amenity based nonmarket values are extensive in the study area and are further discussed in Impacts to socioeconomics.

Public Health and Safety

Earthquakes

The Puget Sound area of northwestern Washington has historically been the most seismically active area of the west coast outside of California (Engdahl and Rinehart 1988; Goter 1994; Yelin et al. 1994). Numerous earthquakes in this region have been of relatively small magnitude; during the last 200 years, no large magnitude earthquakes have exceeded 7.5 on the Richter scale (FERC 1993). However, the recent discovery of additional faults in the area by the US Geological Survey indicates that the seismic (earthquake) risk in the Pacific Northwest is greater than previously recognized.

Most earthquakes in the world occur along zones of contact between mobile crustal plates that make up the surface of the earth. In western Washington, much of the seismic activity is centered on the Cascadia Subduction Zone, which extends 600 miles from Vancouver Island to Cape Mendocino in northern California (Duncan and Kulm 1991; Heaton and Hartzell 1987).

Seismic activity associated with these crustal plate interactions is of three types: deep earthquakes occurring within the descending Juan de Fuca plate, shallow crustal events within the North American plate, and postulated great megathrust earthquakes along the plate interface (Yelin et al. 1994).

Deep Earthquakes

Deep events associated with the descending Juan de Fuca plate originate below the earth's surface at depths greater than 15 miles and can cause large (greater than magnitude 6.5), damaging earthquakes (figure 12). Two large earthquakes originating in the Cascadia Subduction Zone shook the Puget Sound area in 1949 and 1965 (Goter 1994; Langston and Blum 1977). Both earthquakes caused fatalities and substantial economic loss (Yelin et al. 1994). Another more recent deep subduction-type earthquake with a magnitude of 5.0 occurred south of Seattle on January 28, 1995. Analysts agree that future earthquakes with magnitudes up to 7.5 could occur within the descending plate at depths of 15 to 30 miles or more (Ludwin et al. 1991).

Shallow Crustal Earthquakes

Several shallow crustal faults on the North American plate have been identified in the northern Olympic Peninsula (figure 12). The Whidbey Island Fault, situated in the Strait of Juan de Fuca just north of Port Townsend, extends 25 miles from northwest to southeast. The most recent event along this fault zone was a 4.7 magnitude earthquake in 1976. But geologic evidence indicates that an earthquake could occur on the Whidbey Island Fault comparable to large earthquakes on the San Andreas Fault in California (Sam Johnson, USGS, pers. comm., May 23, 1995).

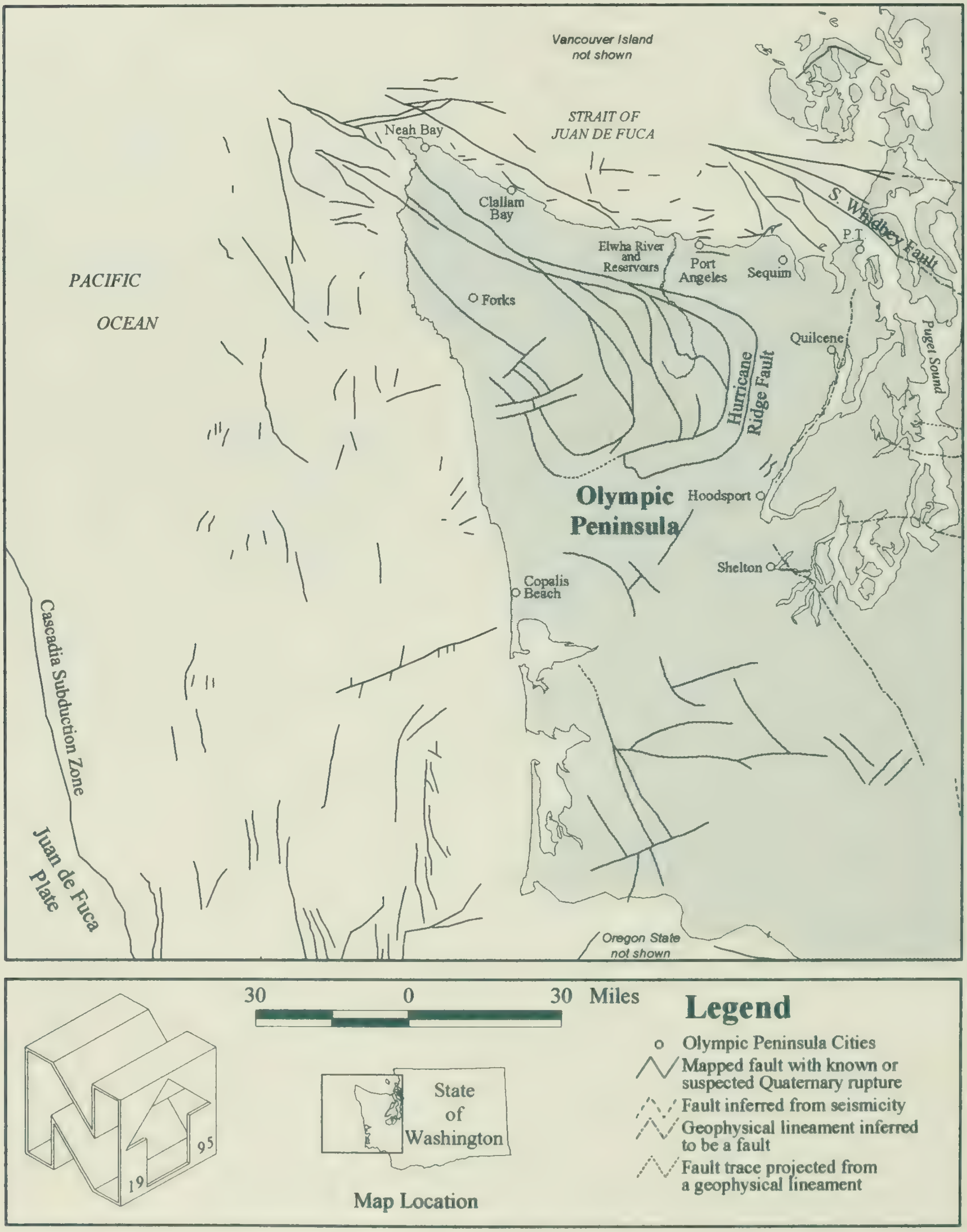
The Hurricane Ridge Fault, another shallow crustal fault located one-half mile upstream from Glines Canyon Dam, is the closest mapped fault to the project area. There is no evidence of recent seismic activity on this fault (FERC 1993). Earthquakes originating from shallow crustal faults in the region have been smaller than a magnitude 6, and none has been associated with surface displacement on mapped faults. However, recent research suggests that larger earthquakes (up to magnitude 7 to 7.5) with associated surface rupture could be potential seismic hazards in the area (Bucknam et al. 1992). Due to lack of data, it is difficult to predict the recurrence interval of earthquakes on shallow crustal faults or deep subduction faults on the Juan de Fuca plate.

Megathrust Earthquakes

The largest earthquakes and the overwhelming percentage of total seismic energy released worldwide has been in subduction zones. Research in the last decade suggests that great megathrust events (magnitude 8 to 9.5 earthquakes) may have occurred during prehistoric times along the Cascadia Subduction Zone (Adams 1984; Heaton and Hartzell 1987; Heaton and Kanamori 1984; Rogers 1988). Before 1984, it was widely believed that the Cascadia Subduction zone lacked seismic activity because there had been no historic earthquakes identified on the plate interface. Adequate geologic

Figure 12. *Fault Map*

Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20073



evidence of past large earthquakes indicates that these great subduction earthquakes should be considered in seismic hazard analyses of high-hazard engineered structures (Atwater 1987; Nelson and Personius 1991). Research shows that the last great earthquake occurred about 300 years ago, and that the average recurrence interval is on the order of 500 years (Adams 1990; Atwater 1987).

The current maximum credible earthquake for Glines Canyon and Elwha dams have not taken into account the recent discovery of increased seismic risks in the region. The US Geological Survey and the Washington Department of Natural Resources are updating seismic occurrence maps for the area and evaluating the potential hazard of the recently discovered faults. This work may result in changes to the maximum credible earthquake for Glines Canyon and Elwha dams which would then trigger a reevaluation of the seismic safety of both dams.

Dam Safety

Both Elwha and Glines Canyon dams are classified as high hazard potential because of the possible loss of life and property downstream in the event of dam failure (BOR 1995g). As a result, both dams have undergone testing to measure their structural integrity under normal operating conditions and have met additional requirements to improve structural integrity imposed by the Federal Energy Regulatory Commission. A procedural history of the tests and measures to improve safety of the dams is in the FERC *Draft Staff Report* (FERC 1993; pp. 2-5 to 2-10).

Safety improvements were made at Glines Canyon Dam in 1969, 1977, 1978, and 1989, when post-tension anchors were added to the dam. In 1978, the US Army Corps of Engineers considered Elwha Dam potentially unsafe for floods greater than 40,000 cubic feet per second and recommended a variety of measures to repair and strengthen the dam. The Federal Energy Regulatory Commission issued an emergency order directing modifications, and additional anchors were installed on the north spillway and intake sections in 1982. All work to strengthen the Elwha Dam to withstand probable maximum floods was completed in 1986.

The Federal Energy Regulatory Commission and the Washington State Department of Ecology, Office of Dam Safety, have indicated that both dams currently meet state safety standards for normal loading, probable maximum floods, and earthquakes. The dams undergo yearly inspections by the commission to assess their structural integrity. In addition, all licensed dams, including the Glines Canyon Dam, undergo a more comprehensive evaluation, a Part 12 Study, every five years. Since it is unlicensed, Elwha Dam has never been the subject of a Part 12 Study.

Elwha Dam was originally built on loose river fill material. The foundation failed in 1912 and the possibility of an increased safety risk associated with the dam's foundation remains. Following a 1994 inspection of the dam, the

US Bureau of Reclamation rated the safety of Elwha Dam as "fair." The "fair" rating means that the dam is considered safe under normal operating conditions, but may be deficient if the probable maximum flood or maximum credible earthquake occur (BOR 1995g).

As part of its dam safety program, the James River Corporation has submitted emergency action plans to the Federal Energy Regulatory Commission since the 1970s. During the first years, all emergency action plans were accepted on an interim basis. For the past 10 years, the Elwha Dam safety plans have been "fully accepted" (James River Corporation 1995). The emergency action plans require James River Corporation to notify the Lower Elwha Klallam Tribe, Clallam County Sheriff, Point No Point Treaty Council, and others when discharges from the dams exceed 3,000, 8,000, and 13,000 cubic feet per second. Installing sirens to notify citizens at the river at the time of a release was evaluated, but James River Corporation concluded it would be ineffective without secondary confirmation. They instead decided to contact affected parties by phone in the event of a flood (Orville Campbell, pers. comm., James River Corporation, Jan. 1995).

Hazardous Materials

Chemicals such as fuel, lubricants, paints, and pesticides stored at various storage facilities and equipment repair areas at both damsites, asbestos wiring in both dams, oil-stained ground caused by leaking transformers at Glines Canyon Dam, pole and pad mounted transformers at both facilities, banks of batteries at both powerhouses, and soil samples containing organochlorine pesticides and PCBs were detected in recent surveys (FWS 1995a, b). See Hazardous Materials Impacts section for more information.

Traffic

Traffic would be generated at the site by construction vehicles moving equipment in and dam rubble and other materials out. The study area included nine disposal sites within 32 miles of the dams.

Existing Roadways

Glines Canyon Dam is reached by Olympic Hot Springs Road, located to the south of US 101 at milepost 239.53, west of Port Angeles. The dam is approximately 4.5 miles up Olympic Hot Springs Road and 3.5 miles inside the boundaries of Olympic National Park. At the intersection with US 101, Olympic Hot Springs Road is a two-lane paved roadway, 20 feet wide with 2-foot shoulders and a speed limit of 35 mph. Inside the boundaries of the park, the roadway becomes narrower and has no shoulders (see figure 2).

US 101, a rural two-lane principal arterial, provides access to Olympic Hot Springs Road. Where it passes Olympic Hot Springs Road, the speed limit on US 101 is 25 mph because of a substantial curve. East of its intersection with

Olympic Hot Springs Road, US 101 has two lanes eastbound and one lane westbound. West of Olympic Hot Springs Road, it has one lane in each direction as it crosses a bridge over the Elwha River. Speed limits on the non-urban portions of US 101 are generally 55 mph. The road configuration varies from two lanes (one lane in each direction) to three lanes (one climbing lane) in areas with appreciable grades.

US 101 is designed and constructed to accept standard truck traffic. Olympic Hot Springs Road consists of a bituminous surface treatment. The Altaire bridge on Olympic Hot Springs Road is designed for heavy loads and would accommodate construction traffic.

The Elwha Dam is reached via Highway 112 and Power Plant Road. Highway 112 is a rural two-lane collector arterial with a speed limit of 55 mph. Power Plant Road intersects Highway 112 approximately 1 mile west of the intersection of Highway 112 and US 101 (at milepost 242.61).

Power Plant Road runs north/south from Highway 112 with the short south leg providing access to Elwha Dam and a small, relatively undeveloped scenic view area. Lower Dam Road consists of an improved gravel surface and is almost entirely located on project lands.

Waste Disposal Areas

Nine potential disposal sites were considered in this study. The waste would not go to nine; they are options for partial or full disposal of solid waste generated from dam removal. The selection of sites would be up to the dam removal contractor and site owners.

Four sites are located near Highway 112, west of Port Angeles. Three of these are reached via Place Road and Ranger Road, and the fourth is accessed by Laird Road, Edgewood Drive, and Lower Elwha Valley Road. All these routes are two-lane rural roadways under the jurisdiction of Clallam County. Laird, Edgewood, and lower Elwha valley roads have weight restrictions posted, but permits can be obtained for trucks to use these routes (figure 13).

Another site, located at the Port of Port Angeles, is accessed via US 101 and Highway 117, which is classified as a minor arterial. It is a two-lane truck route bypassing the City of Port Angeles downtown area. Two sites are located immediately off of US 101, one to the west of Olympic Hot Springs Road at Herrick Road and one to the east of Old Olympic Highway between Port Angeles and Sequim. The two remaining sites are north of Sequim and are reached via US 101 and Old Olympic Highway. One site is off Cays Road and the easternmost site is off Sequim-Dungeness Way. These two-lane rural roadways are under the jurisdiction of Clallam County.

Study area roadways have no special pedestrian, bicycle, or equestrian facilities.

Table 25. *Existing Summer Peak Hour Level of Service (1995)*

INTERSECTION	WEEKEND LOS	WEEKDAY LOS
Marine Drive/Highway 117	B	C
Highway 117/US 101	A	A
US 101/Highway 112	A	A
US 101/Olympic Hot Springs Road	A	A
Place Road/Highway 112	A	A
Ranger Road/Place Road	A	A
Power Plant Road/Highway 112	A	A
US 101/Herrick Road	A	A
US 101/Laird Road	A	A
Lower Elwha Valley Road/Edgewood Drive	A	A
US 101/Old Olympic Highway	A	A
Old Olympic Hwy/Cays Rd.	A	A
Old Olympic Hwy/Sequim-Dungeness	A	A

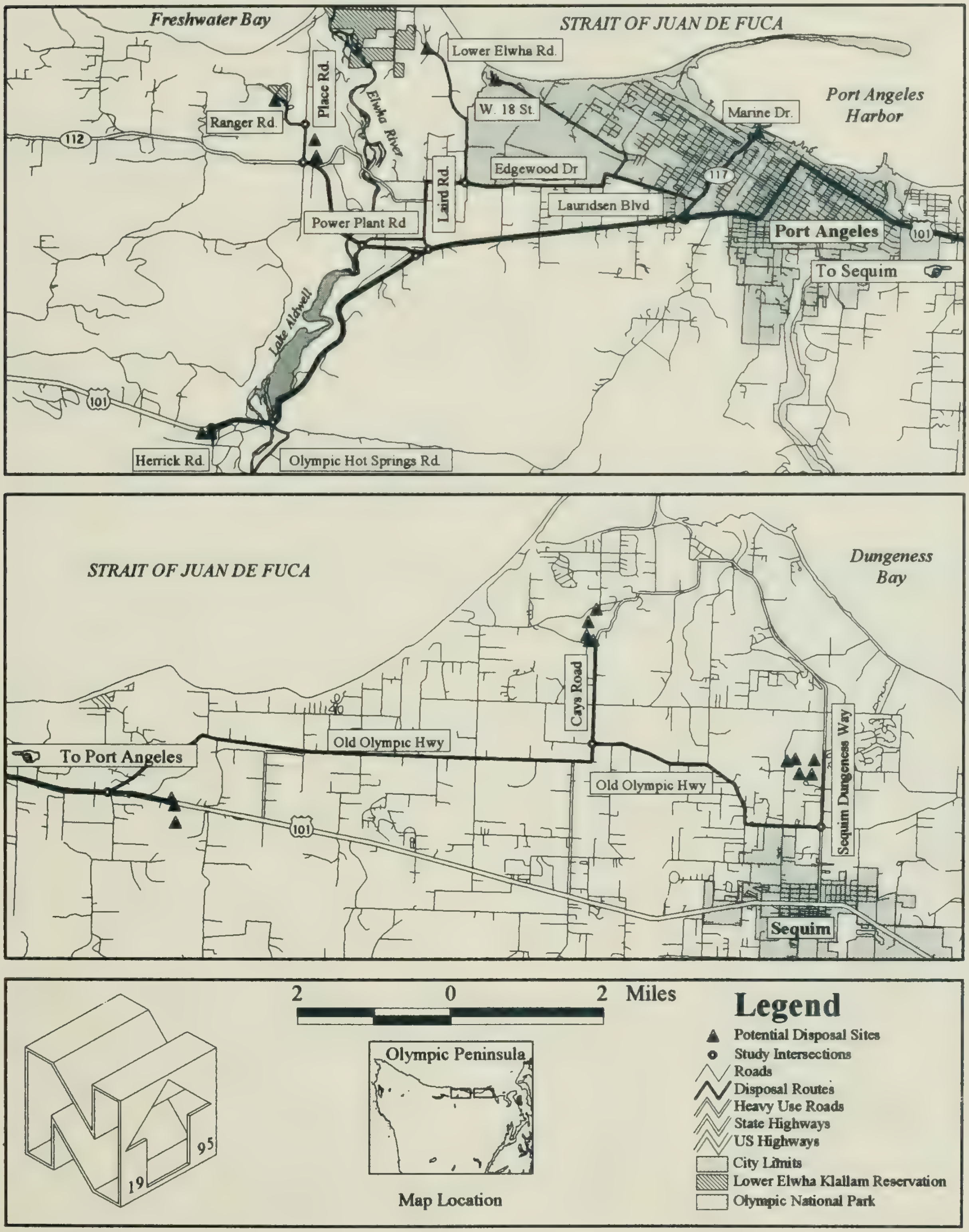
Intersection Volumes

Some of the following 13 intersections may be affected by trucks carrying equipment and dam waste and rubble from dam removal:

- Olympic Hot Springs Road/US 101
- US 101/Highway 112
- Highway 112/Power Plant Road
- Highway 112/Place Road
- Place Road/Ranger Road
- Highway 117/Marine Drive (in Port Angeles)
- US 101/Highway 117
- US 101/Laird Road
- US 101/Herrick Road
- Edgewood Drive/Lower Elwha Valley Road
- US 101/Old Olympic Highway
- Old Olympic Highway/Cays Road
- Old Olympic Highway/Sequim-Dungeness Way

Operating conditions at each of these intersections are indicated in table 25 below by a level of service (LOS) letter designation. The designation provides a measure of delay ranging from A (free flowing, minimal delay) to F (extreme congestion, long delays; see methodology in the Traffic Impacts section for more information). For intersections with signals ("signalized"), average time stopped at the signal is estimated. For unsignalized intersections, total delay is estimated. When volumes exceed capacity, LOS * (star) appears. Although level of service *(star) may sometimes mean the intersection operates at F, this is not always true. The Methodology section of Impacts to Traffic in this document has more information on levels of service designations.

Figure 13. *Potential Disposal Sites & Routes*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20074



Levels of service A through D are generally considered to be acceptable operating conditions at intersections outside of urban areas.

Peak Hour Level of Service

Existing (1995) summer weekend and weekday peak hour intersection operations are shown in table 25. Counts were made (or assumed to take place) during the peak season — August. All study intersections operate at acceptable levels, with most operating at overall level of service A. In many cases, operations on the weekend are better than those during the weekday afternoon peak hour. Although more recreation trips take place on weekends, fewer commercial, truck, and work trips results in improved conditions at many intersections.

Indian Trust Resources

The United States, because of its unique relationship with Indian tribes, has a fiduciary duty to protect certain "trust" resources. For purposes of this project, trust resources include:

1. Indian treaty fishing rights under the Treaty of Point No Point and the Treaty with the Makah, including but not limited to:

   The right to take up to one-half of the harvestable fish returning to or resident at the usual and accustomed fishing places;

   The right to take up to one-half of the harvestable shellfish at usual and accustomed fishing places, except for "staked or cultivated beds;"

   Rights of access to and use of usual and accustomed fishing places.

2. Indian rights, under all the Stevens Treaties to hunt on "open and unclaimed lands."

3. Indian water rights to meet:

   The primary purposes of the Lower Elwha Klallam Reservation and

   The habitat needs, in streams and estuaries, of finfish and shellfish returning to or resident in usual and accustomed places.

Indian trust resources also include the resources subject to these rights, i.e. fish and wildlife populations and habitat. These are described in this document in Fisheries, Wildlife and Living Marine Resources sections.

Trust resources also include Indian trust or restricted lands in the Elwha River drainage, their physical integrity and their quiet enjoyment. Relevant sections of this DEIS include Flooding, Public Health and Safety, Cultural Resources, Socioeconomics, Land Use and Aesthetics.

Recreation

Regional Recreational Resources

The Olympic Peninsula contains numerous federal, state, and county administered recreational areas (see figure 14). Olympic National Park, the state's most visited national park, has approximately 1000 developed campsites, 876,669 acres of wilderness, and well known park features such as the Olympic rain forest and rugged Pacific coastline. Other important visitor areas in the park include Hurricane Ridge, Lake Crescent, and Lake Ozette. The park has an estimated 3.5 million visitors every year, primarily from the Puget Sound area. Outside the park, important tourist destinations and recreational areas include Port Townsend, a historic waterfront city; Neah Bay, a Makah Indian town with an excellent saltwater sport fishery and cultural heritage museum; Lake Quinault, a resort area; and Hood Canal, a popular waterfront area for second homes and retirees. The 649,975-acre Olympic National Forest, almost completely surrounding the park, has several developed campgrounds with 379 sites and an extensive trail network, some of which access the national park.

Popular forms of recreation include hiking, camping, picnicking, sightseeing, wildlife observation, and fishing. Some hunting and whitewater boating are done in the region, although hunting is not allowed in the national park.

Hiker in the Elwha valley.
(Janis Burger photo)

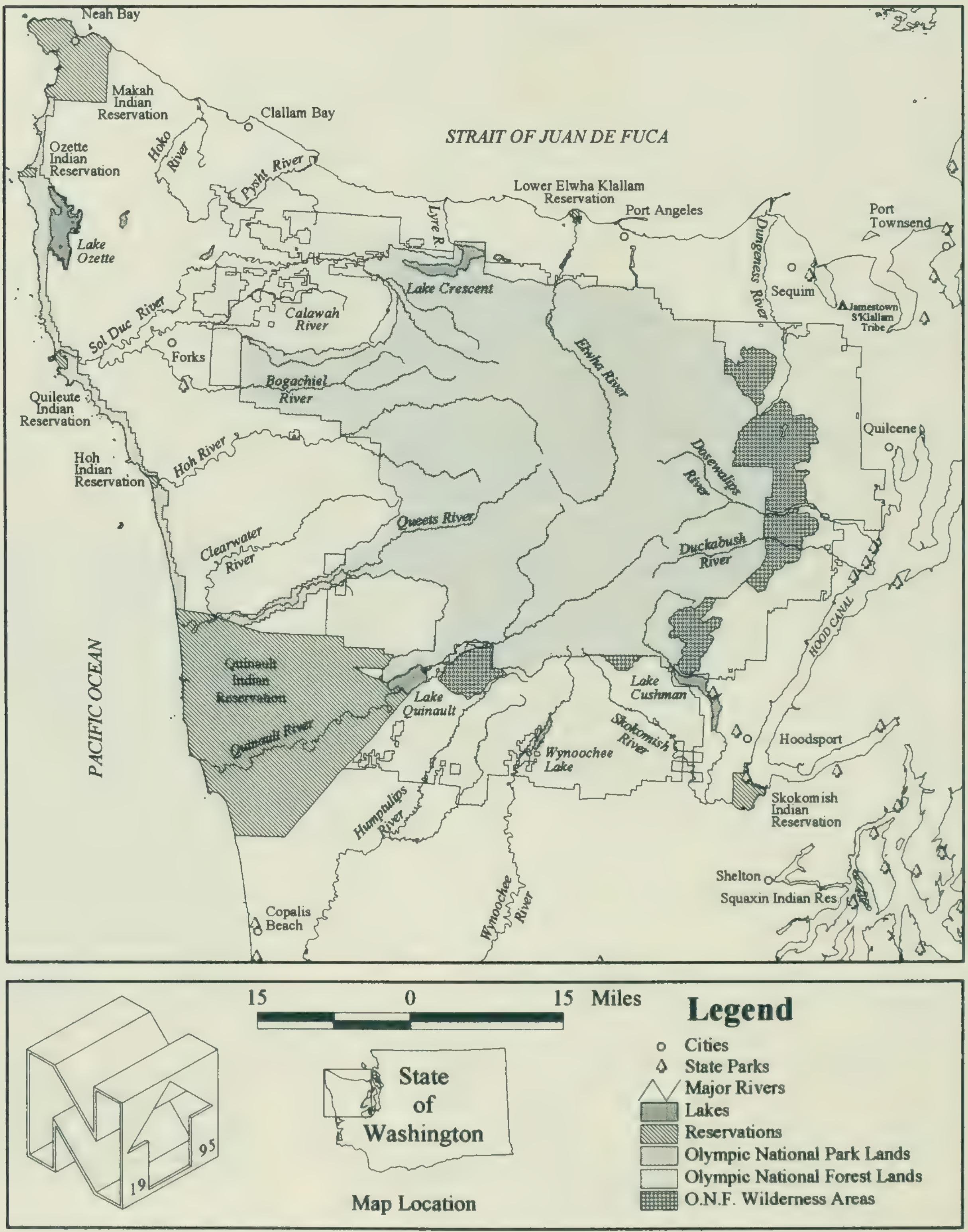
The most popular hiking areas on the Olympic Peninsula are in the national park; these include cross-park corridors such as the Elwha River, Quinault River, and Dosewallips River. Sightseeing includes roadside and trailside wildlife observation, visits to museums and interpretive facilities, and the use of roadside scenic pullouts. Many areas on the peninsula contain developed day-use areas suitable for hiking, sightseeing, and picnicking. A variety of saltwater and freshwater fishing opportunities include fishing for salmon, ling cod, and halibut along the north coast from Neah Bay to Port Townsend. Salmon, steelhead, and other trout fishing is done on the Bogachiel, Sol Duc, Calawah, Elwha, Hoh, Queets, and Dungeness rivers. The nearby Pysht and Lyre rivers also are popular steelhead fishing locales. Whitewater boating opportunities are found on the Humptulips, Queets, Quinault, Wynoochee, and Elwha rivers.

Recreation in the Elwha River Valley

The Elwha is one of several important recreational rivers on the Olympic Peninsula, and the Elwha River valley serves as an important corridor for cross-park and wilderness use within Olympic National Park. The lower Elwha River has a major winter steelhead fishery, and trout fishing is generally rated as very good in the wilderness areas of the upper river. Visitor-use figures for the Elwha River valley from 1990 through 1995, measured at the Elwha Ranger Station, are shown in table 26.

Figure 14. *Recreation Areas*

Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20075



The main recreational uses in the Elwha River area are hiking, fishing, camping, horseback riding, and whitewater boating. Other uses include sightseeing, picnicking, wildlife observation, and hunting.

Recreational Facilities

Access to the Elwha River area is primarily on local roads connecting to US Highway 101 and State Highway 112. Vehicular access to the river is possible at specific locations along the lower 13 miles. Above Lake Mills, the river is accessible only by trail.

Several developed facilities are located in Olympic National Park in the river valley below Glines Canyon Dam (see figure 15). These facilities consist of nine trailheads, five of which are associated with developed sites; the Altaire and Elwha campgrounds; Madison Creek Falls; and a picnic area. The Elwha Campground, on the east bank of the Elwha River, is open year-round and is the trailhead for the Cascade Rock Trail. The Altaire Campground, located on the west bank of the Elwha, is generally operated from May to October each year. Altaire has a boat launch for whitewater boaters and also is the trailhead for the West Elwha Trail. There are several popular undeveloped recreational sites in the wilderness areas of the park and along roadside corridors. Observation Point, above the northwest end of Lake Mills, and several informal fishing pullouts along the road in the middle reach of the river are popular

Table 26. *Monthly Visitor Use of the Elwha River Valley in Olympic National Park*
(1990 to 1995)

	1990	1991	1992	1993	1994	1995
January	3,146	3,016	4,040	1,404	4,877	4,516
February	2,886	2,960	5,746	1,331	5,184	5,559
March	3,140	2,912	9,327	3,112	7,683	9,383
April	3,047	9,966	8,027	9,807	13,624	10,980
May	11,089	10,325	15,143	12,173	14,081	15,342
June	11,695	12,215	25,488	18,959	20,178	23,374
July	11,908	10,717	26,377	24,006	28,935	29,905
August	13,928	13,312	31,694	26,645	35,747	28,522
September	23,141	10,780	17,857	21,754	19,315	19,955
October	2,886	8,323	8,731	9,404	9,846	10,041
November	2,366	5,055	5,398	5,660	5,975	10,041
December	1,872	1,888	4,326	3,798	4,846	4,256
TOTAL	**91,104**	**91,469**	**171,940**	**138,053**	**170,291**	**171,874**

SOURCE: Loretta Hansen, ONP.

day-use areas with little or no associated development. Fishing in the Elwha River and the Lake Mills reservoir is subject to National Park Service regulations.

The Olympic National Forest administers a two-mile-wide strip of land bordering the park as part of the Sol Duc Ranger District. Forest Service land in this area along the Elwha River is managed to provide a variety of recreational opportunities in a scenic environment while maintaining or enhancing wildlife and fish habitat (USFS 1990). There are no developed facilities in the national forest in this area.

The Washington Department of Fish and Wildlife administers 109 acres along the lower Elwha River below Lake Aldwell. A spawning channel and a fishing site on the east side of the river are accessible from the Olympic Hot Springs Road (Elwha Valley Road). The Department of Fish and Wildlife also administers a boat ramp on the south end of Lake Aldwell; this property, donated by the James River Corporation, is accessible directly off US 101. The department manages all sport fishing outside park boundaries. Under current regulations, the lower river from the mouth to 200 feet below Elwha Dam is open for sport fishing (trout and steelhead) from June to mid-April each year with a trout catch limit of two fish of at least 12 inches. Lake Aldwell is open to sport fishing (resident species) mid-April through October each year with the same size regulations and limits as in the river. The Elwha above Lake Aldwell also is under the same regulations as the lower mainstem river, although the open season is from June to October each year and fishing is not allowed within 400 feet of Glines Canyon Dam.

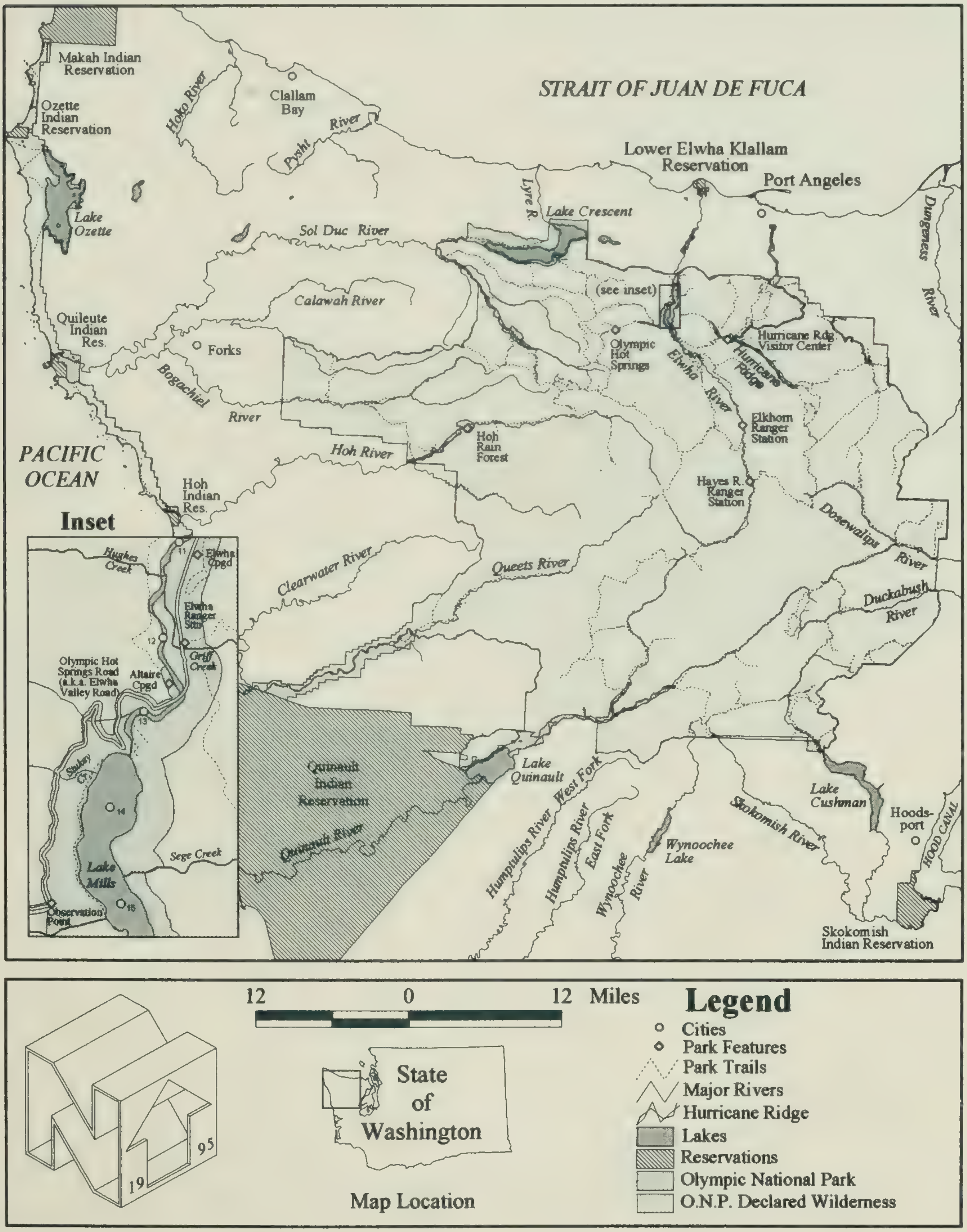
The James River Corporation administers a boat ramp facility on the north end of Lake Mills and allows recreational use on all lands and waters except those near the dam intake structures and tailrace areas. The facility contains a gravel-surfaced parking area, launch lane, floating finger-dock, toilet, four picnic tables, and serves as a trailhead for the West Lake Mills Trail. An informal, steep hiking trail near Elwha Dam provides anglers access to pools below the dam. In addition, an informal equestrian trail runs from the Elwha Dam westward toward the rural residential areas along Dan Kelly Road.

Recreational Fishing

The recreational fishery of the Elwha River focuses on resident trout and hatchery-produced winter steelhead. The upper Elwha River from the Elkhorn Ranger Cabin to the Hayes River has been considered one of the best fishing rivers in the park (Kirk 1980). Lakes Aldwell and Mills also receive some use during the summer trout fishing season. The eastern shoreline and the north end of Aldwell provide good fly fishing.

Both the in-river winter steelhead and saltwater salmon fishery in the Strait of Juan de Fuca have been excellent in past years. Some of the largest numbers of steelhead caught on the Olympic Peninsula were raised at the Elwha River hatchery, and the sport fishing around Ediz Hook and Freshwater Bay has

Figure 15. *Olympic National Park Features*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20071



been consistently good to excellent. However, the last few years have been very poor; the entire salmon sport fishery in the strait was shut down in 1994, and the 1995 season was greatly reduced with no planned coho fishery. The winter steelhead fishery is most popular during December and January, and the summer steelhead fishery in July.

The salmon sport fishery, administered by the Washington Department of Fish and Wildlife, is customarily open October through December. Six coho salmon over 10 inches in length may be taken, with only two fish over 20 inches allowed; any chinook or pink salmon must be returned to the river. Charter fishing boats operate out of Port Angeles.

Other Recreational Activities

Both day and overnight hiking are popular in the Elwha River valley. Overnight hiking in the backcountry is popular during the summer months. Nine trailheads in the Elwha drainage basin provide access to 20 designated trails in the wilderness areas of the basin. Of the nine trailheads, five access trails of three miles or less are the most popular with day users. Trails such as Cascade Rock, Griff Creek, West Elwha, and the two Lake Mills trails provide views of the river valley.

Table 27. Overnight Backcountry Visitor Use Nights in the Elwha River Valley, Olympic National Park[a]
(1990 to 1995)

	1990	1991	1992	1993	1994	1995
January	118	27	99	132	147	153
February	29	150	156	199	149	130
March	279	311	670	546	349	578
April	376	490	500	550	481	572
May	772	874	853	1,131	1,140	1,178
June	1,158	962	1,149	1,090	1,650	1,960
July	2,599	2,527	2,811	2,790	2,872	3,498
August	3,754	3,808	3,687	3,573	4,276	2,284
September	1,465	1,522	1,789	1,808	1,537	1,755
October	340	543	441	574	507	523
November	83	216	235	176	168	213
December	35	129	89	97	75	50
TOTAL	**11,008**	**11,568**	**12,483**	**12,671**	**13,351**	**12,894**

[a] These numbers are also included in the visitor use numbers in table 26.

SOURCE: Loretta Hansen, ONP.

Overnight use, by hiking or horseback, is popular in the Boulder Creek drainage and upper Elwha valley. National Park Service visitation figures, obtained from self-registered backcountry permits, shown in table 27, show total annual overnight use in wilderness areas of the Elwha Subdistrict ranging from approximately 11,000 to 13,300 persons during 1990-1994. During the same period, the Elwha and Altaire campgrounds each received between 5000 and 8000 visitors annually. During peak use periods, such as summer weekends, all frontcountry campgrounds are at full capacity.

In addition to the Elwha and Altaire campgrounds, two private resorts, Elwha River and Indian Creek, contain campgrounds. Most camping is during the summer months using tents and trailers. The resorts also offer cabin and cottage accommodations. A small private RV park is located off Lower Dam Road and Highway 112.

Rafting on the Elwha.
(David King photo)

The Elwha River between Glines Canyon Dam and upper Lake Aldwell is used for whitewater boating. Kayaks and rafts are both used in the intermediate-rated stretch between the Altaire Campground and the Elwha Resort; the Gorge Rapids area, above Altaire Campground, provides more difficult conditions for whitewater enthusiasts. One commercial outfitter operates out of the Elwha River Resort; another out of Port Angeles offers guide service for kayaking. The primary put-in site for most whitewater trips is at the Altaire Campground and the primary take-out point at the Elwha River Resort. While commercial float trips are scheduled only for the spring and summer (April through September), many others make trips in winter and early spring. In addition to whitewater boating, there is limited access for day-use activities on the beach areas at the mouth of the river.

A scenic view pullout is located at the Elwha River bridge off Highway 112 and Lower Dam Road. The Elwha River valley is popular with bird watchers year-round.

Land Use

Regional Landscape Setting

The Elwha valley is currently used for recreation, timber production, power production, fish harvest, and residential purposes. The upper and middle reach of the Elwha within Olympic National Park boundaries is primarily dedicated to wilderness preservation and recreational use, while the middle and lower reaches outside of the park have mixed use including residential, forestry, and limited commercial development. The lower river valley is a mosaic landscape of active logging, forest, pasture, quarries, small commercial enterprises, recreational developments, two fish hatcheries, and rural residential. The Lower Elwha Klallam Reservation occupies 534 acres at and near the mouth of the Elwha River.

Olympic National Park is famous for its snowcapped peaks, wet and remote old-growth forest valleys, and water-carved rock and sand beaches. In 1988, most of Olympic National Park and the Elwha River valley, except the Glines Canyon dam area (and Lake Mills), became federally designated wilderness. According to National Park Service management policies, the primary responsibility for these areas is the preservation of wilderness character and resources while providing for appropriate use. The protected wilderness attracts many backpackers seeking remote and pristine experiences. The vehicle-accessible front country includes campgrounds, scenic viewpoints, and short trails.

Land use is described in the following subsections in terms of land ownership, existing land use, and land use plans.

Land Ownership

About 83% of the Elwha watershed is pristine and protected within park boundaries. The James River property, which includes Glines Canyon Dam and appurtenances plus a portion of Lake Mills, is the largest (about 160 acres) of several privately owned parcels within the park boundaries in the Elwha watershed. Figure 16 illustrates current land ownership patterns. Public land ownership along the middle and lower reaches is shared by the National Park Service, U.S. Forest Service, Washington Department of Natural Resources, and the Washington Department of Fish and Wildlife. The U.S. Forest Service owns about one square mile of land immediately east and west of the river in the middle reach. Washington Department of Natural Resources lands, primarily managed for timber, are located in large tracts on either side of the project lands at Lake Aldwell and on the western bluffs above the river's lower reach. The Washington Department of Fish and Wildlife administers about 109 acres along the lower reach of the Elwha. These lands are used for the rearing of salmon, as well as by anglers for access to the lower river.

Olympic National Forest, Washington Department of Natural Resources timber trust lands, and privately owned commercial timber companies are the major landowners in the eight miles between the park boundary and the north end of the Aldwell reservoir. Green Crow Corporation owns 130 acres on the Elwha River in two non-contiguous sections. Rainier Evergreen, Inc. owns 140 acres on both banks of the river. The City of Port Angeles owns 100 acres within the drainage.

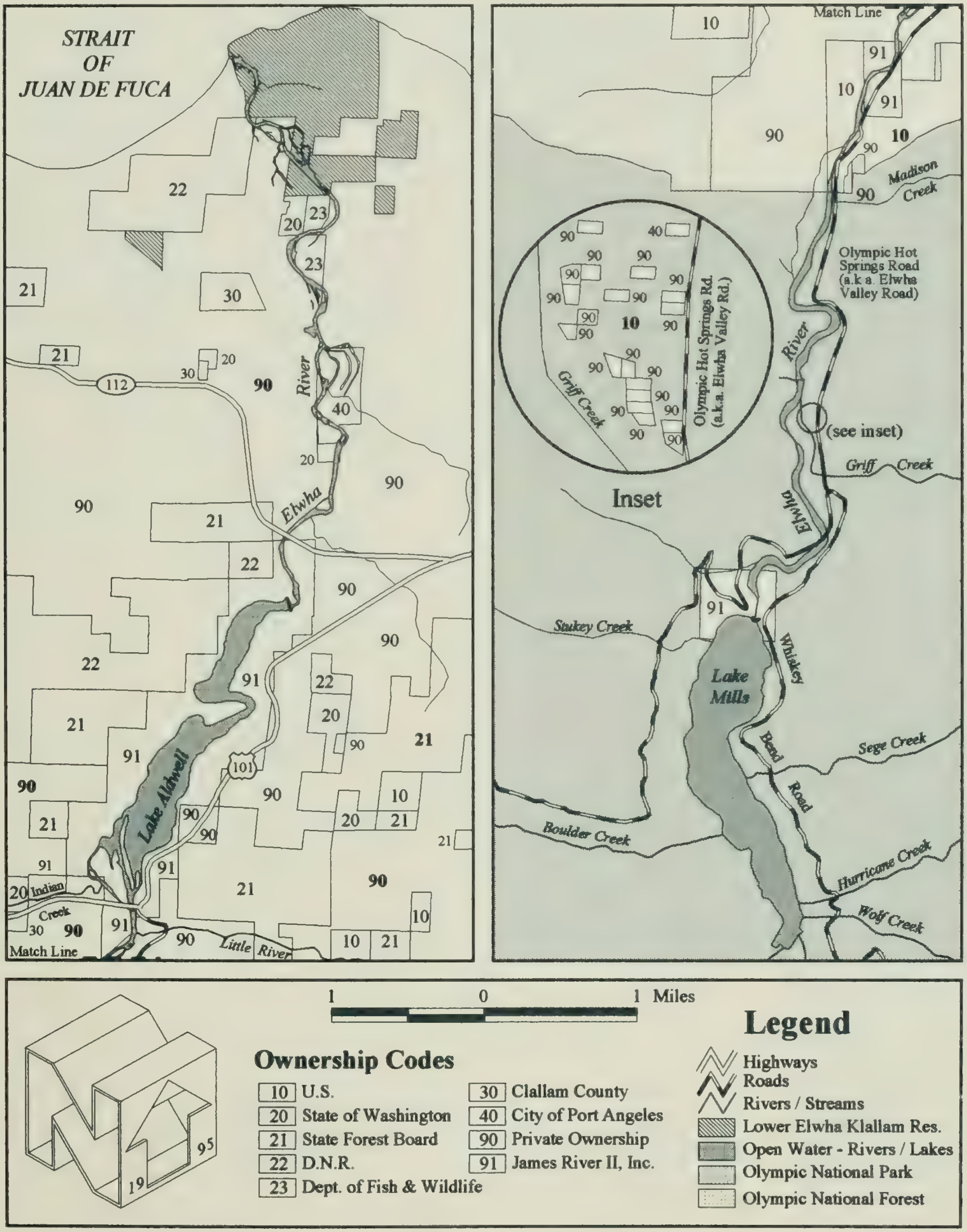
There are several private landholders along the middle and lower river reaches. The James River Corporation owns all of the approximately 1,018 acres of project lands surrounding Lake Aldwell, including the site of the Elwha Dam

Figure 16. *Land Ownership*

Olympic National Park

United States Department of the Interior - National Park Service

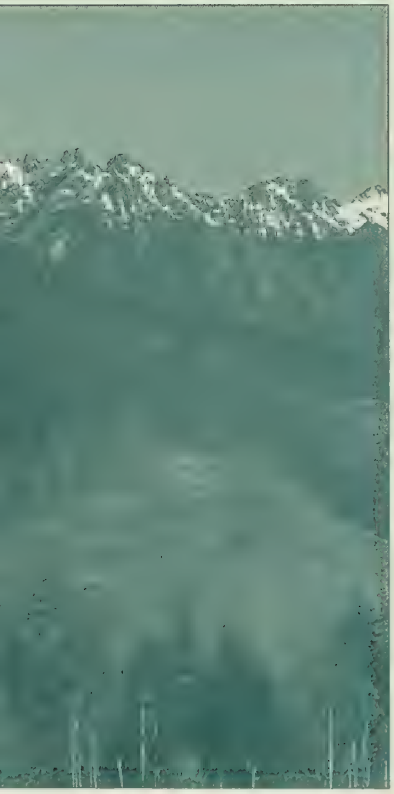
DSC - December 1995 - 149 - 20076



and powerhouse and the land leased to the Elwha Resort. Timber companies and private individuals own tracts adjacent to and above the river shoreline in the lower reach. In addition, privately owned residential sites line the east side of the river between the park entrance and the dam. Most of the lower five miles of the river valley, to the boundaries of the Lower Elwha Klallam Reservation, is privately owned and subject to county zoning and development regulations. The majority of the parcels in this section are 5 to 15-acre residential homesites. Eight private landowners hold a total of 849 acres in large lots (over 40 acres), several of which have development proposals pending.

The Lower Elwha Klallam Reservation occupies 534 acres at and near the mouth of the Elwha River, including 20 acres above the west bank of the river along Ranger Road. About 400 additional acres within or near the watershed are held in trust by the federal government for Indian families.

Subject to other valid existing rights, the State of Washington owns in fee the beds and shores of all navigable waters in the state, including tidelands, shorelands, and the beds of navigable lakes and rivers (WDNR 1992). These aquatic lands are primarily managed by the Washington Department of Natural Resources and are held in trust for the people of Washington. State management objectives are to sustain long-term ecosystem and economic viability, and to ensure public access and benefits derived from aquatic lands.



Clearcuts on state and private lands near Olympic National Park. (Janis Burger photo)

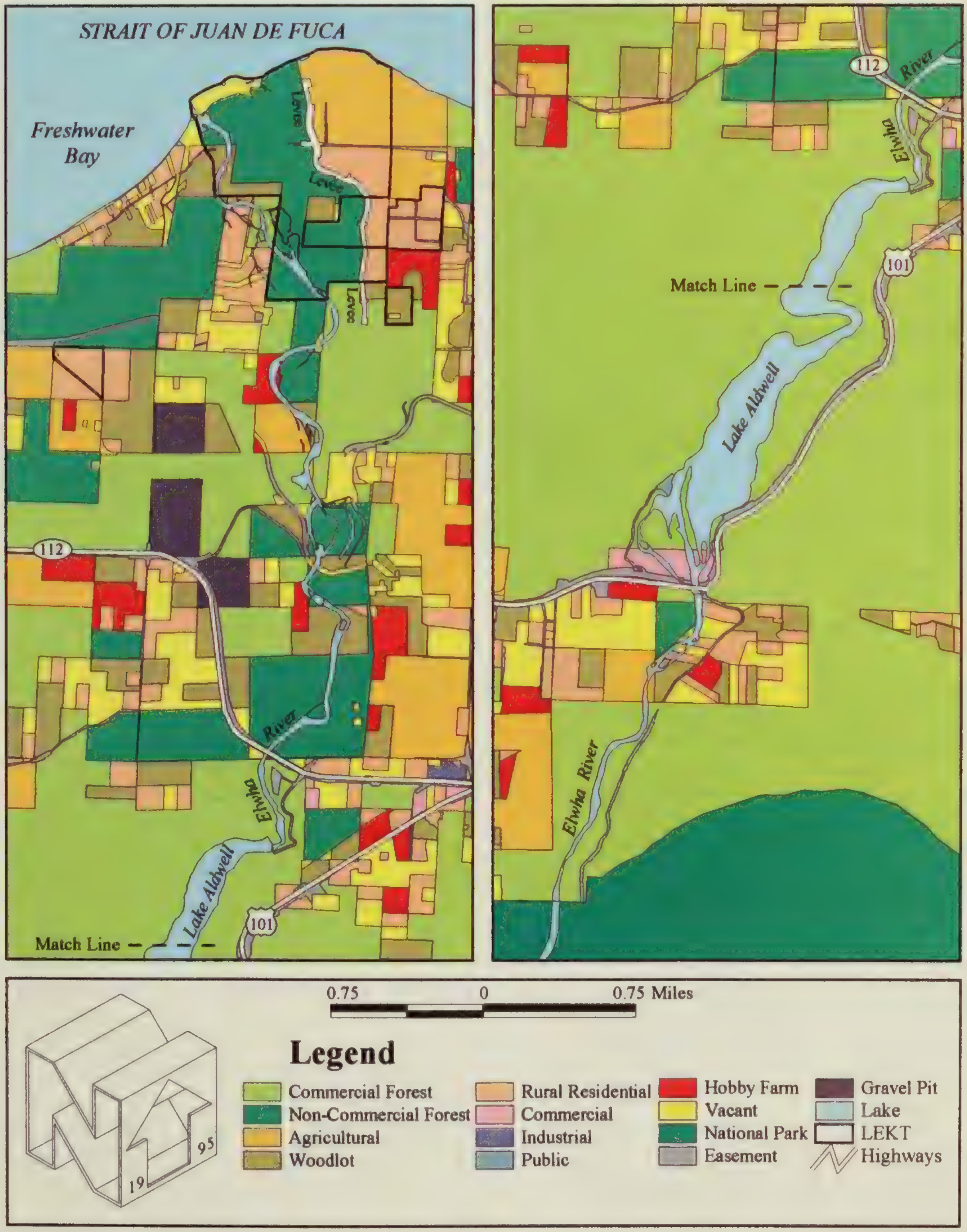
Existing Land Use

Uses of the Elwha River valley are commercial, industrial, residential, and recreational (see figure 17). Upper Elwha River lands within Olympic National Park are managed for preservation and protection of biological and wilderness resources.

Management of biological resources outside the park occurs through a variety of managers: Olympic National Forest, Washington Department of Natural Resources, Washington Department of Fish and Wildlife, the Lower Elwha Klallam Tribe, and Clallam County. Timber production and forestry are managed by the Washington Department of Natural Resources, Olympic National Forest, and private timber owners, depending on land ownership, in the lower middle and lower river reaches. Most of these lands are on 30 to 50-year harvest cycles and were last harvested 20 to 30 years ago.

A portion of the middle and lower river lands is dedicated to power generation and transmission. The Glines Canyon Dam has about seven miles of transmission line. This line generally follows the Olympic Hot Springs Road on a 100-foot right-of-way located partially on National Park Service land. Other utility lines serving the Elwha valley on adjacent rights-of-way are operated under renewable five-year special use permits from the Park Service. About eight miles of transmission lines cross private land and extend into Port Angeles from the Elwha Dam. Electrical power production is for the exclusive use of the Daishowa America Mill.

Figure 17. *General Land Use*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20077



Clallam County has implemented county wide zoning to guide the type and distribution of the various residential, commercial, and industrial developments. A large portion of the land along the middle and lower river is zoned for forestry uses. The forestry use designation is intended to protect large forest tracts from encroachment of uses that threaten effective forest management practices. This designation allows for housing densities as high as one house per five acres in some places, particularly in the lower reach. Residential zoning in the lower reach allows up to one house per 2.5 acres depending on the specific classification.

Land-Use Plans

Future land uses of the Elwha River watershed will be guided in part by management guidelines, land use plans, and the philosophies of the agencies and governments with jurisdiction. Brief descriptions of land use plans and their anticipated effects on the Elwha watershed follow.

Management goals are to maintain all the components and processes of naturally evolving park ecosystems...

Federal Plans

Olympic National Park. Olympic National Park has several plans that direct management of park resources. The park is guided by National Park Service Management Policies, its 1976 master plan, 1983 land protection plan, 1989 statement for management, and 1992 resource management plan.

NPS Management Policies require that the management of natural resources is based on park management zoning. Natural resources in natural zones are to be managed for fundamental ecological processes. Management goals are to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and ecological integrity of plants and animals (NPS 1988a, 4:1). NPS policies also call for the restoration of natural aquatic habitats and the natural abundance and distributions of associated terrestrial habitats and species.

The master plan addresses general management, resource management, and visitor use. Under general management objectives, the plan calls for managing back country areas as wilderness, acquiring all private inholdings, and coordinating management of mutual resources with other jurisdictions. Resource management objectives call for the restoration and maintenance of the primary natural resources of the park. Visitor use objectives include the concentration of high-density usage in park periphery areas, and communication of natural resource values to visitors who use back country areas.

The statement for management states that the first of the park's five primary management goals is to conserve, maintain and restore, where possible, primary natural resources and those ecological relationships and processes that would prevail were it not for the advent of modern civilization (NPS 1989).

The land protection plan identifies methods to ensure the protection of the natural, historic, scenic, cultural, recreational, and other significant resources, and to provide for adequate visitor use. The plan identifies about a dozen small (1/10 acre) inholdings called the Elwha Recreation Sites located in a subdivision near the Elwha Campground. The Elwha River has cut through the Recreation Sites, washing them out and subjecting them to seasonal flooding. Remnants of a concrete bridge, old utility boxes and some brick camp platforms still remain, but there is no development on the Sites, nor is any allowed. These parcels are being acquired by the park on a willing- seller basis.

Additionally, the resource management plan calls for continuing NPS intervention in the Elwha Dam licensing proceedings noting restoration of the Elwha River ecosystem as a primary goal of the park.

Olympic National Forest. There has been little to no recent activity on national forest land in the drainage, and none is expected according to the Sol Duc Ranger District. The 1994 *Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl* amends the *Olympic Forest Plan*. In it, the Elwha is identified as a key watershed with primarily late successional and riparian reserve lands. A watershed analysis, riparian reserve strategy, and late successional reserve plan are required before any operations, including pre-commercial thinning, can take place. The Elwha currently is not on a priority list for this planning process, and there are no adaptive management areas within the drainage.

Fishery Management Plan

The National Marine Fisheries Service and the Pacific Fishery Management Council jointly prepared the *Fishery Management Plan for Commercial and Recreational Salmon Fisheries Off the Coasts of Washington, Oregon, and California* in 1978. Updated in 1989, the plan addresses recreational and commercial fishery regulations within the coastal regions of Washington. Under the plan, objectives are set for habitat preservation, production, and escapement of each salmon species. The Elwha is included with all other Puget Sound rivers and streams. The objectives for the Puget Sound rivers apply primarily to the natural production of chinook and coho stocks.

The most relevant management objectives for these stocks in rivers such as the Elwha include the restoration and enhancement of natural production to their optimum levels. Objectives for production state that whenever fish habitat or population losses occur as a result of development, the fishery agencies should actively seek full compensation, such as restoration of lost habitat, to boost fish production to previous levels. The plan emphasizes the need to maximize the ocean recreational catch and duration of season in order to reduce the impacts to recreationists and local communities.

State Plans

The Washington State Department of Natural Resources *1992 Forest Resource Plan* states that sustainable, even-flow timber harvest is a goal for forest holdings; the preferred policy option is to calculate even-flow harvest level by individual counties. The Department of Natural Resources has about 800 acres of forest land in the Elwha drainage scheduled for full or partial harvest within three to five years.

The Washington Department of Fish and Wildlife operates a fish rearing channel on the Elwha on land owned by the City of Port Angeles. About 20 acres between the rearing channel and the river mouth are managed to protect water supply, habitat, and streambank access. The state has no plans for changing these land uses. The department has implemented a plan, Strategies for Wildlife (WDW 1987), to protect the state's wildlife resources. Some of the plan's statewide objectives are (1) a requirement for provision of adequate fish passage facilities at dams; (2) to maintain and increase, where possible, sustainable wild trout populations; and (3) to establish in-stream flows to protect wildlife. The plan's first priority is to establish and perpetuate the highest quality wildlife habitat.

Statewide Comprehensive Outdoor Recreation Plan. The *Washington Outdoors 1990 Assessment and Policy Plan* is one element of the Washington Statewide Comprehensive Outdoor Recreation Planning Program. The policy plan provides a five-year plan of action for the management of Washington recreation resources. The plan addresses issues such as trails, open space, water resources, and recreation on federal lands. The need for new trails is recognized as a priority statewide; the major policy focuses on the need for a coordinated trail planning effort on a statewide basis. The water resources issue is one of seeking to better balance the preservation of rivers with power generation, withdrawals, and other economic uses. The plan notes that free-flowing river opportunities are disappearing statewide and encourages the addition of new rivers into protective systems such as state and federal wild and scenic rivers.

Other Plans

Lower Elwha Klallam Tribe. The Lower Elwha Klallam Tribe governs land use and development of the reservation. Traditionally, ecologically sensitive areas of riverbanks and shorelines have been reserved for low and no impact community use and kept from development. Land use planning on the reservation is in progress and at this time the Tribe does not have formal zoning. The construction of the Lower Elwha Federal Flood Control Levee resulted in about 315 acres of tribal land (and an additional 40 acres of private land) between the river and the levee which is now treated as a conservation area without standard development. The 200+ acres east of the levee currently support about 250 residents and employees, 2 churches, 30 houses, the tribal fish hatchery, Tribal Head Start facility, and the Tribal Center. Expected development of the reservation includes increasing the amount of housing and community services. The tribe is engaged in long-range planning and surveying to facilitate allocation of land for housing and other needs. Wellhead and wetland protection programs that direct development away from sensitive areas are currently being implemented.

Clallam County. The *1995 Port Angeles Regional Comprehensive Plan* and *County-wide Comprehensive Plan* guide the orderly growth and development of the county. The plan pertains to unincorporated areas of Clallam County, exclusive of federal, tribal and state lands. The *County-wide Comprehensive Plan* provides general policies and guidelines for growth; the *Port Angeles Plan* specifically addresses the Port Angeles watershed and includes plans for watersheds east of the Elwha. Residential, commercial, and industrial uses in the middle and lower Elwha River area are generally guided by Clallam County zoning and shoreline management designations. The zoning code is currently being developed and is expected to be in-place by 1996.

Pockets of residential dwellings and a few, small gravel quarries located primarily along county roads are in the lower Elwha valley. A primary concern is flooding (see Affected Environment chapter, Flooding section of this EIS); Clallam County participates in the Federal Emergency Management Agency flood insurance program.

The plan's recreation policy states that it is critical that growth policies protect and enhance recreational resources, so that significant numbers of visitors, vitally important to Clallam County's economy, continue to be attracted.

Figure 18 shows Clallam County's proposed land use designations for all zoning classes, indicating permitted future uses of privately held, unincorporated lands within the Elwha watershed. The Commercial Forestry zone, intended primarily for timber management, allows one residence per 80 acres. The Commercial Mixed Forest zones, which buffer residential zones from commercial zones or commercial forest, allow one residence per 20 acres.

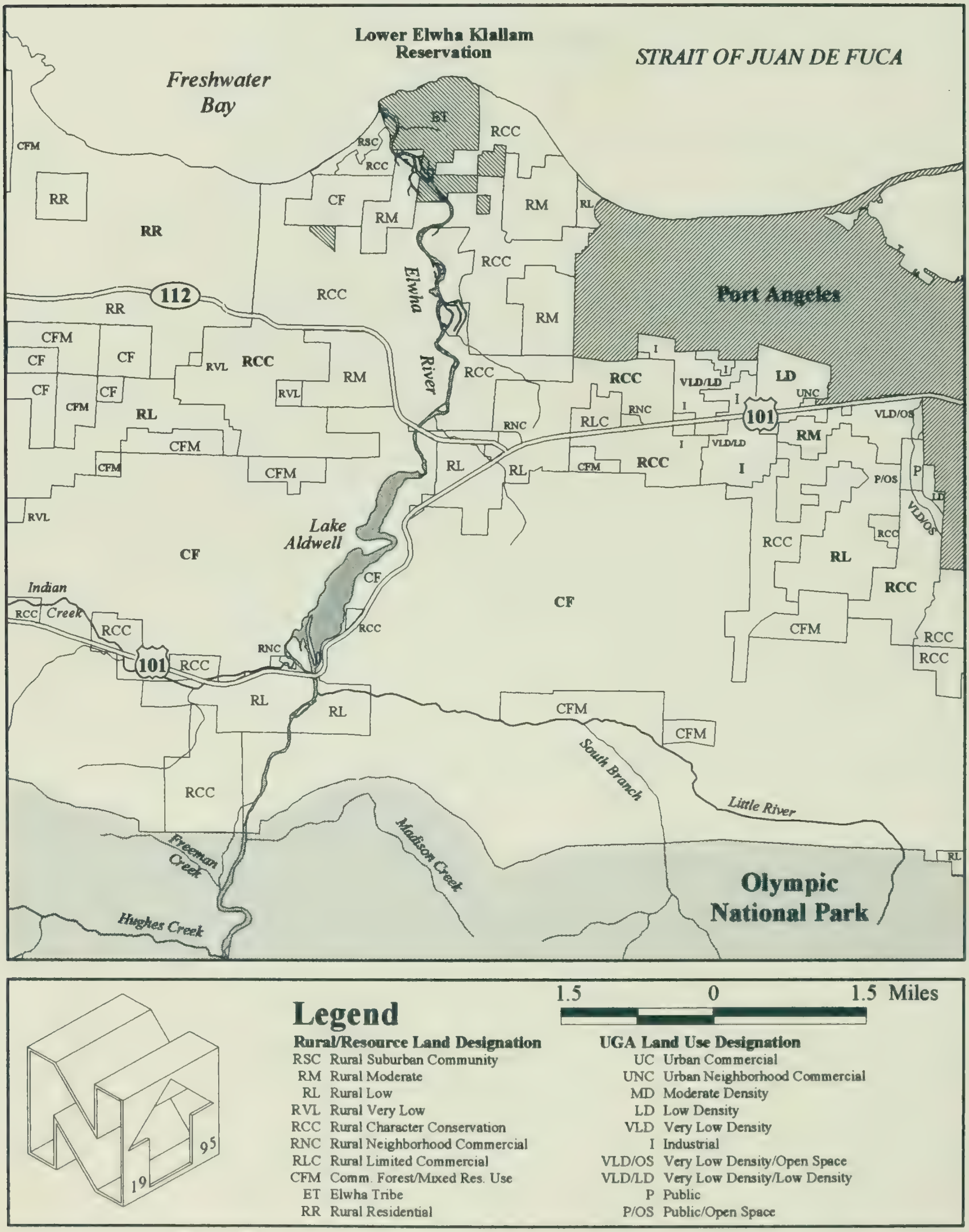
The Rural Character Conservation designation encourages housing clusters with preservation of open space. This zone allows one dwelling per 10 acres or a mixture of small lots with stipulations. Other zones within the corridor include Rural Low Density (one dwelling per 5 acres) and Rural Very Low Density (one dwelling per 20 acres).

Shoreline Master Program. Clallam County's Shoreline Master Program is also part of the Washington State Coastal Zone Management Program. The 1989 Clallam County Shoreline Master Program addresses land use within 200 feet of rivers, streams, lake fronts, and coastal shorelines. The goal of the plan is to preserve, to the fullest extent possible, the scenic, aesthetic, cultural, and ecological qualities of the shorelines of Clallam County. The plan is implemented through county wide shoreline designations.

The Elwha River has three shoreline designations outside Olympic National Park. The middle reach of the river and coastal zone at the mouth are designated as rural — marked by intensive agricultural or recreational use. The shorelines of Lake Aldwell are designated natural — areas that are largely

Figure 18. *Zoning*

Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20078



undeveloped and relatively intolerant of intensive human use. The lower reach of the Elwha is designated as conservancy shoreline for which protection from development is warranted because of steep slopes, flood protection, or areas which cannot be provided with adequate water supply or sewage disposal. In addition to the three specific zones, the entire Elwha River is considered a shoreline of statewide significance. This designation requires local governments to recognize statewide interest over local interest, to preserve the natural character of the shoreline, and to enhance public access and recreational opportunities.

Aesthetic Resources

A full explanation of aesthetic resources requires both a description of views and the way people are affected by them. The views are called "visual resources," and the way people are affected by them, "viewer exposure."

Visual resources consist of landform (topography and hydrology) and land cover (vegetation, buildings, roads, etc.). In describing visual resources, it is important to pay special attention to outstanding features and settings (such as a prominent mountain peak) and intrinsic features (such as vegetation, geological formations, and land uses that are typical of or particularly express a sense of place for the regional landscape).

Viewer exposure includes factors such as visibility of the project, the number of people who see it, viewer distance from the project, and duration of the view; for example, the difference between a quick view from a car and a longer duration view from a picnic spot.

Visitors and residents have many opportunities to experience the different landscapes that make up the visual resources of the Elwha River basin. Rural residences, local roads, and campgrounds have visual access to the river although views are typically restricted by vegetation and topography. A viewpoint sign on Highway 112 states "Elwha Canyon Scenic Viewpoint," but there is a limited view of the canyon and mostly the highway bridge is visible.

Public and private viewing spots located in each of several landscape areas, i.e. visually distinct divisions of the river valley, are described below. Access locations, and visitors' characteristics and numbers are reported in the Recreation section. While there are many visual and physical access locations in the basin, the public has few opportunities to see the damsites because of their remote locations and lack of visibility due to topography and vegetation. Views affected by dam removal are in the mountainous, and forested foothills landscape areas.

Regional Landscape

The visual character of the region is dominated by the Olympic Mountains, a subdistrict of the Pacific Coast range physiographic region. The Olympic Mountains consist of a mass of folded and metamorphosed rocks eroded into steep-sided ridges that reach to 8,000 feet; glaciers are found on the highest mountains. Most of the region is drained by short, fast-moving rivers and streams. These rivers deposit sediments that add to the marine terraces, sand beaches, and spits found along much of the coast. The district is bordered by the Pacific Ocean, Puget Sound, and the Strait of Juan de Fuca. Heavy rainfall, particularly in the mountains and along the west coast, combine with temperate climates to produce dense coniferous forests, many of which have been subject to clear-cutting in the lower elevations.

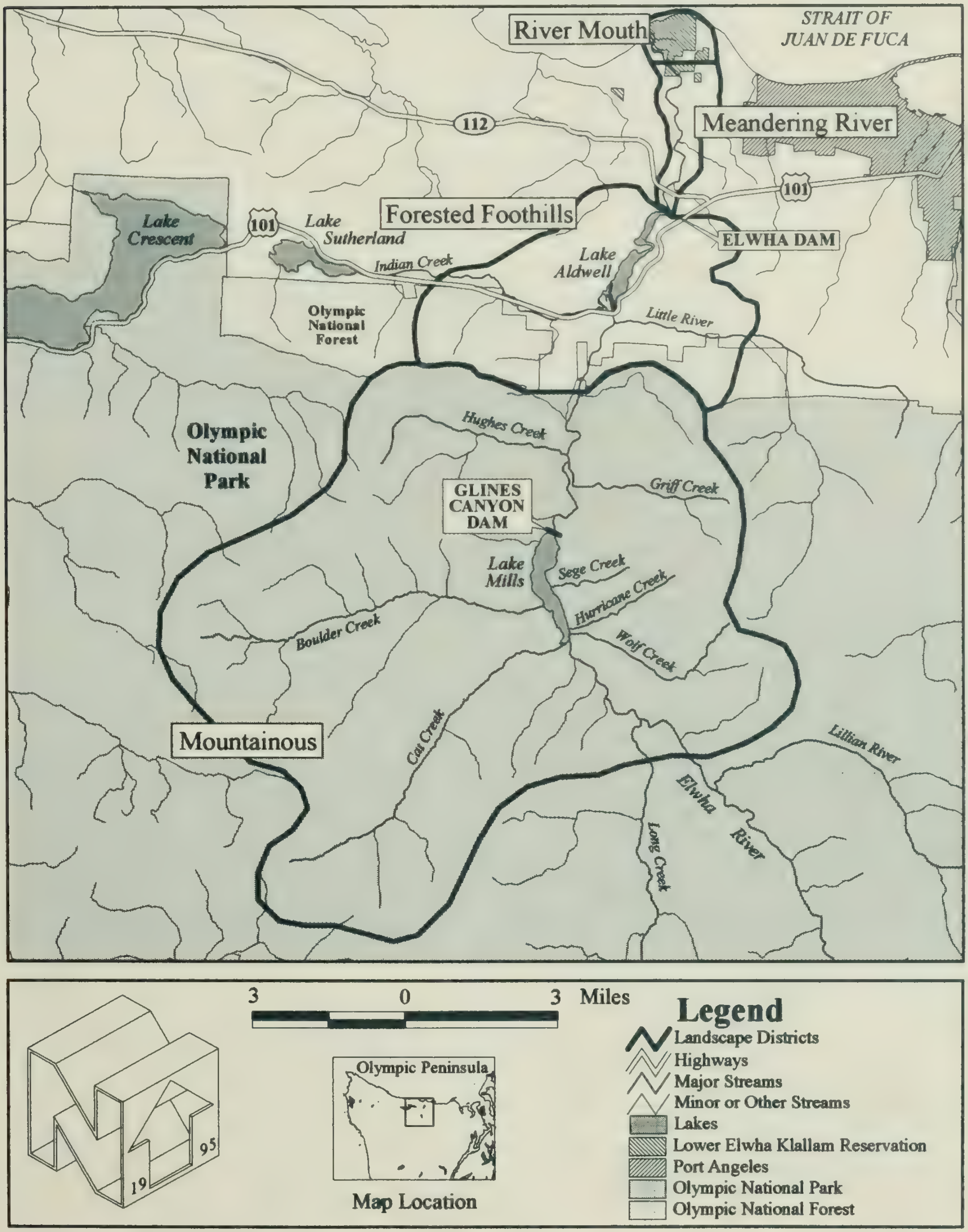
Old growth forest valleys include the Hoh Rain Forest; the Hoh, Sol Duc, and Quinault rivers are nationally famous for their scenic qualities. One of the prominent views from Hurricane Ridge, the highest elevation access to vehicles in the park, is to the southwest into the upper Elwha River basin.

Project Area Landscape

The Elwha River basin can be divided into four landscape areas, each possessing a distinctive combination of visual resource characteristics. Since they are defined by visual resources, the boundaries of these landscape areas are slightly different from the upper, middle, and lower reaches described elsewhere in this document. The Glines Canyon transmission line is described separately below.

Elwha River.
(Curtis Miller photo)

Figure 19. *Landscape Districts*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20080



Mountainous Landscape Area

Visual Resources. The mountainous landscape area encompasses more than 80% of the river basin (approximately 265 square miles) from the headwaters to the park boundary. This area is within the boundaries of Olympic National Park, and is protected wilderness. It is characterized by mountain peaks, steep-sided valleys with swift-flowing streams, and pristine forests. Glines Canyon Dam and powerhouse are located on a 160-acre private inholding in high contrast to the surrounding wilderness area. The park's wilderness attracts many backpackers seeking remote and pristine experiences; hikers have opportunities here to link walks into adjoining watersheds. The vehicle-accessible frontcountry includes campgrounds, viewpoints, trailheads, and access points to Lake Mills.

Lake Mills, approximately 2.5 miles long, 0.5 mile wide, and 140 feet deep, fills a forested valley. Vehicular access to the lake is from both the east and west shorelines near the dam, including a primitive boat launch on the west bank with hiking trails along the west shoreline. Filtered views of the lake and surrounding mountains are available from the Upper Lake Mills Trail as it descends from Whiskey Bend Road and terminates at the southeast end of the reservoir, and from the Lake Mills Trail to Boulder Creek.

The Glines Canyon Dam is a 210-foot-high concrete arch built into a very narrow canyon (see figures 5 and 27). The straight rim and smooth concrete face of the dam contrast in form and texture with the rugged canyon walls. The tops of the dam and spillway are fenced to block public access. Both physical and visual access are provided from the Whiskey Bend and Olympic Hot Springs roads.

Visible from Olympic Hot Springs Road are the light green surge tank, the white facade of the powerhouse, and white painted residential and maintenance facilities. Large clearings have been created around the buildings. Views of the dam and other structures are generally limited to short glimpses from the road as visitors pass on their way to or from backcountry trailheads.

Viewer Exposure. Visitors to the dam and Lake Mills reservoir turn off Highway 101 and travel the Olympic Hot Springs Road past the park entrance, ranger station, and campgrounds. The Griff Creek and Cascade Rock trails leave the valley bottom in this area and have occasional views of Lake Mills and the Elwha River valley.

Park visitors heading up Olympic Hot Springs Road get a momentary direct view of Lake Mills as they pass the boat launch area. Otherwise, most direct, expansive views of Lake Mills come from the boat launch area itself, informal view points near the dam, and from the West Lake Mills Trail, popular with day users. Both Whiskey Bend Road and Olympic Hot Springs Road provide occasional filtered views of Lake Mills; Observation Point, a pullout on Olympic Hot Springs Road, provides north-facing overviews of Lake Mills and the entire middle and lower Elwha River valley.

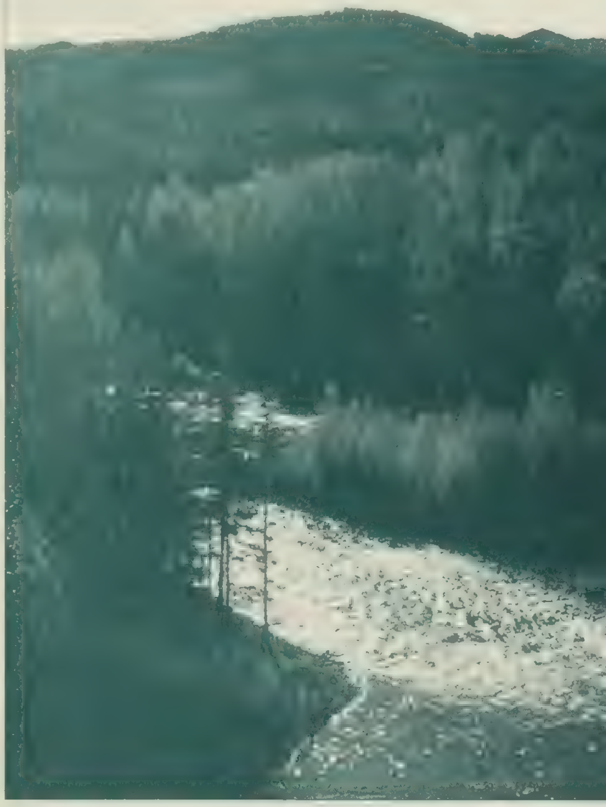
Whiskey Bend Road, a single gravel lane with occasional pullouts, leaves Olympic Hot Springs Road below the dam. Forest cover blocks views to the river and lake except for a few distant glimpses. There is a pullout on the east side of Glines Canyon Dam where visitors can walk a short distance to the dam and lake. The terminus of the road is a major trailhead for backcountry trails within Olympic National Park. Although there are no views to the lake or river from this point, visitors can hike farther upstream for views and access to the free-flowing Elwha. At the southern end of the lake, prior to the Whiskey Bend trailhead, the 0.5-mile long Lake Mills Trail leads steeply to the lake and Wolf Creek waterfall.

Forested Foothills Landscape Area

Visual Resources. The forested foothills landscape area, from the park boundary to the north end of Lake Aldwell, is characterized by rounded hills less than 2,000 feet in elevation, a U-shaped river valley, and a mosaic of cleared and forested timber lands. Olympic National Forest, the Washington Department of Natural Resources, and privately owned commercial timber companies are the major landowners in this area. Their forest practices have major influences on the visual resources as seen from surrounding roads, trails, and viewpoints.

The construction of Elwha Dam flooded a pristine 65-foot-deep canyon, creating Lake Aldwell 2.8 miles long and 0.3 miles wide (figure 25). For years, the reservoir elevation varied approximately 5 feet annually, but since 1983 it has been held to within 1 foot. The shoreline and surrounding hills are forested. The only visible developments are the reservoir itself, the facilities at the dam, a residence on the east bank overlooking the reservoir and Elwha Resort at the Highway 101 bridge. The steep topography and forest cover screen views into and out from the lake basin.

Elwha River.
(Curtis Miller photo)



The Elwha Dam appears unusual to viewers accustomed to the large scale, clean lines, and materials of typical public power projects on the Columbia River. Most of the view of the Elwha Dam consists of the powerhouse, penstocks, and auxiliary structures (see figures 4 and 23). A primitive fishing trail and Lower Dam Road provide access to views of the actual dam structure. The weathered concrete and mosses growing in the face of the dam are very similar in color to the exposed rock of the canyon wall.

From the Lower Dam Road, the transmission line right-of-way is first visible with more distant views to the powerhouse, penstock, and dam complex. The transmission line right-of-way is cleared of vegetation. Native vegetation also has been cleared from all utility buildings and structures. These structures have been painted white and are in open view.

Since the original construction, numerous modifications have resulted in a visually disorganized complex of small peripheral buildings of differing architectural styles, materials, and colors on both the east and west banks near the dam. The white office and maintenance buildings and old and new powerhouse stand out prominently in the muted color landscape. The above-ground penstocks, surge tank, and other metal features are galvanized or painted in light colors.

The entire facility is a significant man-made visual presence in an otherwise natural scene. Although the facilities are not designed for public access or viewing, visitors are allowed to walk across the dam and spillways which are fenced for public safety. There is minimal access to the downstream canyon and no recreational facilities on the north end of the lake. Viewing is from the road, dam, or by boat.

Viewer Exposure. Although Highway 101, the major transportation route on the peninsula, parallels Lake Aldwell on the east, vegetation and topography block almost all direct views to the reservoir. Motorists get a broad view of the south half of Lake Aldwell and the distant mountains where vegetation has been cleared at an undesignated pullout on the west side of the highway. Other than this one pullout, motorists cannot see the reservoir and the river valley until they cross the Highway 101 bridge. Logging operations and a few residences are visible along this section of the highway.

Highway 101 crosses the Elwha River immediately above the delta area of Lake Aldwell. Although there are no developed viewpoints, the river is visible from Elwha Resort located at the river crossing. A gravel road leads to a boat and fish access point on the southwest lakeshore--the only signed public access on the lake. The dam complex on the north end of the lake is accessed from an unsigned county road off Highway 112. There are no developed trails or campgrounds, but anglers fish below the dam and sightseers occasionally walk across the dam. An unimproved trail heading west from the damsite allows occasional horseback riders and hikers views of the lake.

Meandering River Landscape Area

The meandering river landscape area, from Elwha Dam at river mile 4.9 to the beginning of the broad floodplain at approximately river mile 1.5, is characterized by a meandering river in a well–defined river valley cutting through the marine terrace. The modified landscape is a mosaic of different land-cover patterns composed of active logging, forest, rural residential, pasture, small commercial enterprises, and other rural uses. Views in the meandering river landscape area would not be affected by dam and reservoir removal.

River Mouth Landscape Area

The river mouth landscape area constitutes the lower 1-1/2 miles of the river to the estuary at Freshwater Bay on the Strait of Juan de Fuca. This area is characterized by a braided/meandering river in a broad floodplain and a mix of forest, pasture lands, and rural residential development. The Lower Elwha Klallam Reservation occupies 534 acres along the lower Elwha River. Views in the river mouth landscape area are not affected by dam and reservoir removal.

Glines Canyon Transmission Line

The transmission line from the Glines Canyon powerhouse parallels the Olympic Hot Springs Road to Highway 101 and crosses the highway a number of times on H-shaped wooden towers. North of Elwha Dam, the transmission line continues cross-country rather than paralleling local roads. Within Olympic National Park, single pole towers have been used.

Aesthetic Resource Management

Diverse land ownerships and management policies within the project areas have resulted in distinctly different aesthetic resource management settings.

Although the 160-acre core of the Glines Canyon project area is privately owned by the James River Corporation, the surrounding lands and waters are publicly owned and managed by the National Park Service. Unlike Lake Aldwell, surrounded primarily by private timber lands, Lake Mills is located in the national park, portal to the federally designated wilderness and

Elwha River delta.
(Charles Scott photo)

UNESCO-designated World Heritage Site and Biosphere Reserve. The park service established visual themes for management of the park and the Elwha valley in 1989 (NPS 1989) appropriate for this internationally significant landscape. They emphasize preserving the visual dominance of natural elements and keeping man-made changes subordinate. The policy states:

> *The natural wilderness, untrammeled qualities of the natural ecosystems is the overall park theme. It is stated in the park's enabling legislation, is reflective of the outstanding visual qualities and characteristics of the park, and emphasizes the reasons visitors come to the park. The natural elements must always be primary and be complemented by any introduction of man-made objects or improvements (NPS 1989).*

...Lake Mills is located in the national park, portal to the federally designated wilderness and UNESCO-designated World Heritage Site and Biosphere Reserve.

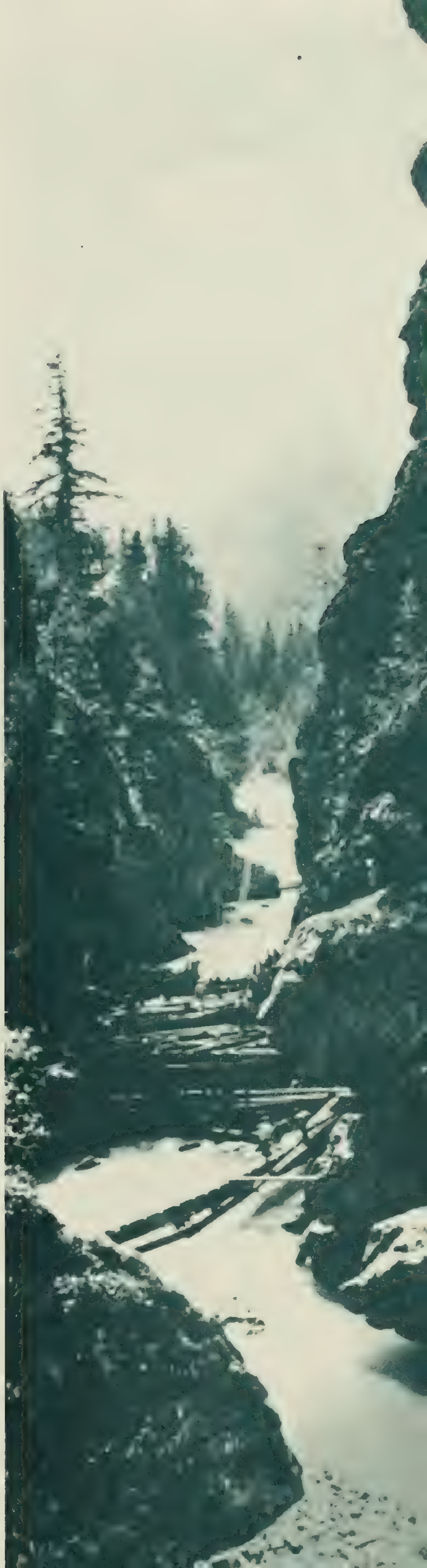
The document also defines the relationship of constructed objects to the natural elements and settings in parks in terms of complementing colors and materials. Important historic resources are also addressed; policy dictates that these resources should be protected or restored if possible. In response, Olympic National Park has aggressively pursued the inventory and documentation of both dams to record their detailed construction history, as well as identified pieces of the Glines Canyon Dam which should be retained for interpretive value (see Alternatives and Cultural Resources sections in this environmental impact statement).

Olympic National Forest lands at the south end of Lake Aldwell and along US Highway 101 are being managed according to visual quality objectives developed using the Forest Service Visual Management System. The forest service has designated most of these lands as "partial retention," i.e. that forest management practices such as logging remain visually subordinate to the characteristic landscape features and patterns.

The Elwha Dam and its reservoir, Lake Aldwell, are on private property. Within the viewshed of Lake Aldwell are state lands managed by the Washington Departments of Natural Resources and Fish and Wildlife. The Department of Natural Resources has plans to log a portion of these lands over the next three to five years. These agencies neither manage their lands to protect aesthetic resources nor do they have policies or programs for scenic protection.

The Clallam County comprehensive plan does not specify design regulations to protect scenic values along the Elwha River; however, land use zoning ordinances and the Shoreline Master Program address shoreline setbacks, open space, and landscape screening, which can indirectly protect scenic resources to varying degrees.

Impacts



Previous page: *Glines Canyon before dam. (Daishowa/James River Company photo)*

1. Glines Canyon Dam construction; "water overflowed—workers rescued." (Clallam County Historical Society)

2. Glines Canyon Dam near completion. (Daishowa/James River Company photo)

3. Glines Canyon Dam, 1995. (Charles Scott photo)

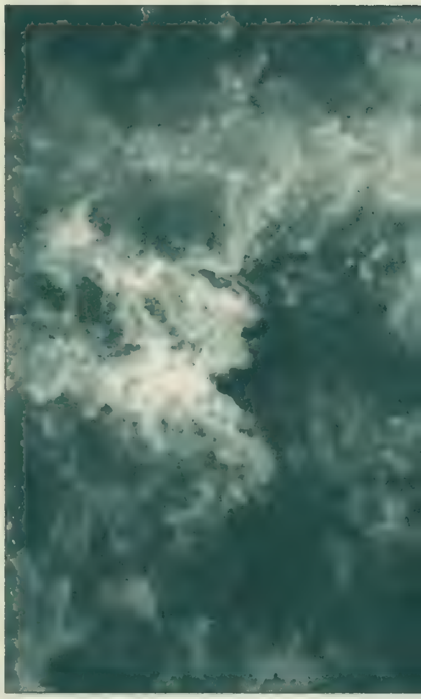
Impacts

Fluvial Processes And Sediment Transport

Summary of Regulations and Policies

Impacts and therefore regulations regarding the release of stored sediment affect water quality, downstream property (as a result of increased flood stage), fisheries and marine life. Applicable regulations are covered in these sections. Generally, the Washington Department of Ecology administers state permits, with statutory authority from the federal Clean Water Act, including the National Pollution Discharge Elimination System, Water Quality Certifications, and Short-Term Modifications of Water Quality Standards.

The Water Quality Certification is a statement that the proposed activity would comply with applicable water quality standards. Since many projects unavoidably violate state water quality criteria on a short-term basis (particularly for turbidity), Short-term Modification of Water Quality Criteria permits are issued by the Washington Department of Ecology.



White water in the Elwha.
(Janis Burger photo)

Methodologies for Analyzing Impacts

Assessment of the potential impacts to fluvial processes is based on comparison of the short- and long-term river channel responses to the No Action and two sediment management alternatives. Impacts on fluvial processes and sediment transport are directly related to fisheries, water quality, and flooding conditions of the river. Channel and water conditions continually change in natural river systems and are not in themselves considered impacts; it is the potential changes to flooding, bank erosion, water quality, and fisheries conditions that are of interest.

Many sources of data were used to predict how and to what degree stored sediment would be released. New and earlier reservoir and river sediment water samples were analyzed. A stream gauging site established upstream of Lake Mills recorded stage, temperature, and sediment discharge. Lake Mills was drawn down 18 feet and monitored extensively during a reservoir drawdown test during April 1994 (Childers, pers. comm., 1995). The manner in which sediment would erode from the reservoirs, its effect on water quality and the degree of aggradation (rise in riverbed elevation), and its relation to downstream flooding were all mathematically modeled (BOR 1995f). Changes to the river mouth and coastal zone were evaluated by comparison to regional coastal processes.

Impacts of No Action

River Morphology

Overall. The Elwha River below Glines Canyon Dam meanders less frequently and over less of its floodplain than before the dams were built. This is because sediment transport has been blocked, and riverbed sand and gravel are largely absent. The loss of riverbed material has also dropped the river's elevation, and the water is now more often confined within the channel boundaries. The river bottom is armored with larger rocks and boulders, which move only in the largest floods. This contributes to a channelized, rather than meandering river morphology. Because the movement of bedload scours and redeposits on the streambed, vegetation cannot easily establish itself in most sand and gravel bed rivers. However, in the Elwha, gravel bars have become stabilized and well vegetated. The loss of streambed material and its effect on reducing the meandering nature of the river have significant implications for native and anadromous fish species (see Impacts of No Action to Fisheries).

In addition to altering the channel morphology, the dams have resulted in direct impacts to the river by inundating 5.3 miles of the Elwha River. A map of the Lake Mills area made prior to dam construction in 1921 and several photographs of the reservoir area taken before inundation (James River II 1987) show a broad, slightly meandering and locally braided channel with gravel and cobble bars with an average slope of 0.7% percent. The channel was bordered by extensive, gently sloping terraces up to 800 feet wide (James River II 1990).

Upstream of Lake Mills to Glines Canyon Dam (Upper Reach). Lake Mills now inundates 2.5 miles of the Elwha River. The Glines Canyon Dam has trapped an estimated 13.82 million cubic yards of sediment and created the Lake Mills delta (table 14). The upstream portion of the delta in Rica Canyon and the Cat and Boulder Creek fans contain approximately 1.55 million cubic yards of mostly coarse-grained material. The main delta contains 6.97 million cubic yards, up to 70 feet thick in some areas. Downstream of the delta are 5.3 million cubic yards of fine-grained lakebottom sediments composed mostly of silt, clay and some sand-sized materials (table 14).

Glines Canyon Dam to Elwha Dam (Middle Reach). Lake Aldwell inundates 2.8 miles of the Elwha River. The reservoir consists of two wide alluvial reaches divided by a bedrock ridge. Approximately 3.88 million cubic yards of sediment are trapped in Lake Aldwell and its delta (table 14). The main delta contains an estimated 1.78 million cubic yards, and is as much as 40 feet thick. About 2.1 million cubic yards of fine-grained material lie in the lakebed downstream from the delta.

Over time, the Elwha River will continue to deposit all the coarse- and some fine-grained sediment in Lake Mills and Lake Aldwell, resulting in gradual filling of the reservoirs over the next several hundred years (300–400 years for Lake Aldwell, 200-300 years for Lake Mills).

Elwha Dam to the River Mouth. The pre-dam river migrated throughout its entire floodplain; nearer the mouth, it moved laterally over an area 1.2 miles wide. The erosion action of the meandering river prevented the establishment of a mature evergreen forest. Because the channel has shifted less frequently since the dams were built, dense, woody vegetation has grown in near the mouth and serves to increasingly constrain the river in the lower reach. The federal Lower Elwha flood control levee, situated on the east side of the floodplain, confines the eastward migration of the river. Constructed in 1988, the levee was built to withstand the 200-year flood and to provide flood protection for approximately 300 acres in the lower Elwha River floodplain. Based on empirical relationships and historical evidence from aerial photographs, the levee was located beyond the limits of the river meander-belt width. However, it was not built to be structurally capable of constraining main channel migration if meander-belt width expands, as would be expected in the long term following dam removal (COE 1987).

A 900-foot-long privately owned levee extending downstream from the high river bluffs on the west side of the river near its mouth also restricts the floodplain.

Delta area and beaches. The dams continue to block the natural supply of coarse-grained sediment to the river downstream. The only sources of coarse sediment are those in the 3 miles upstream from the mouth, i.e., erosion of loose material (alluvium) and of the bluffs that lie along the west side of the river. As a result, sediment yields to the delta have dropped to 5900 cubic yards per year, or approximately 2% of the pre-dam volume. The drastic reduction in coarse-grained sediment supply from the river has caused some beach erosion (75-150 feet of shoreline recession, FERC 1993, p. 3-19) and erosion of the western edge of Ediz Hook.

Bluff above the lower Elwha River near its mouth at the Lower Elwha Klallam Reservation. (Janis Burger photo)

The US Army Corps of Engineers, which spends approximately $100,000 annually (January 1995 figures) to control further erosion of Ediz Hook, estimates that sediment supplied from the river before the dams were built was between 50,000 and 80,000 cubic yards per year. Currently, the river contributes a negligible volume of sediment to Ediz Hook. Marine cliffs east of the river mouth also supplied sediment to the beaches and Ediz Hook, but this source, too, has been vastly reduced. In 1930 and again in 1958, these cliffs were stabilized to control erosion and to protect a city water supply pipeline at their base. It is estimated that the dams on the Elwha River have reduced sediment supply to the coastal zone between the Elwha River mouth and Ediz Hook by approximately 35%. Stabilization of the marine cliffs is estimated to have reduced beach and hook sediment supply by 55%.

Conclusion

The dams have had a major impact on the character of the Elwha River and nearshore area. The river channel is armored and meanders over less of its floodplain as a result of the decreased sediment supply. Reduced amounts of sand and gravel delivery to the river mouth and coastal areas exacerbate the coastal erosion in the Angeles Point and Ediz Hook areas and cause further recession of the offshore delta. These impacts would continue if the No Action alternative is selected.

Large cobbles in area deprived of smaller sediments, below Glines Canyon Dam. (Janis Burger photo)

Impacts of the Proposed Action – River Erosion Aternative

The proposed action allows natural river processes to erode the reservoir sediments during dam removal. The impacts to various resources, such as fish, water quality and flooding, of naturally eroding these stored sediments are covered in separate sections in this document.

Reservoir Areas

Since both reservoirs would behave similarly during dam removal and change similarly following dam removal, they are analyzed together. This is also true for both sections of the river (i.e., below Glines Canyon Dam and below Elwha Dam).

The reservoir drawdown period would last an estimated 500 days. During dam removal, there would be three long periods of high sediment concentration separated by two periods of low sediment concentration. Table 28 illustrates the dam removal scenario for the proposed action, the expected concentrations, and duration that suspended sediments would be released during and after dam removal.

Mathematical model results predict that much of the coarse-grained sediment would remain in the reservoir areas over the long term after dam removal (BOR 1995f). Of the 8.5 million cubic yards of coarse sediment currently trapped in both lakes, only about 14 to 30% (1.2 million to 2.6 million cubic yards) would be eroded downstream from both reservoirs. Most of the eroded

Table 28. *Range of Final Sediment Release During and Following Dam Removal — River Erosion Alternative (Proposed Action)*

SOURCE OF IMPACT	TIME OF IMPACT	SUSPENDED SEDIMENT CONCENTRATIONS AND DURATION
Begin lake drawdown for dam removal	Starting in June, year 1	31 to 43 days less than 200 ppm[a] 123 to 217 days more than 200 ppm 52 to 170 days more than 1,000 ppm 0 to 26 days more than 10,000 ppm 6,700 to 43,000 ppm peak concentration
Stop dam removal during winter floods and to protect migrating fish	Starting in November, year 1	20 to 85 days less than 200 ppm (close to background levels)
Continue dam removal after winter floods	Starting between December, year 1 and February, year 2	0 to 3 days less than 200 ppm 20 to 126 days more than 200 ppm 20 to 83 days more than 1,000 ppm 0 to 2 days more than 10,000 ppm 5,600 to 11,000 ppm peak concentration
Stop dam removal during high spring runoff and to protect migrating fish	Starting in April or May, year 2	80 to 100 days less than 200 ppm (close to background levels)
Complete dam removal after high spring runoff	Starting in July and lasting to late October, year 2	0 days less than 200 ppm 90 to 111 days more than 200 ppm 87 to 108 days more than 1,000 ppm 3 to 25 day more than 10,000 ppm 15,000 to 51,000 ppm peak concentration
Flood induced erosion following dam removal	Starting November, year 2 through September, year 4	606 to 698 days less than 200 ppm 9 to 103 days more than 200 ppm 5 to 79 days more than 1,000 ppm 2 to 6 days more than 10,000 ppm 21,000 to 38,000 ppm peak concentration

[a] Parts per million (ppm) by weight

sand from the reservoirs would be transported to the Strait of Juan de Fuca to reform the pre-dam Elwha delta at the river mouth. The character of the riverbed would change from boulders and large cobbles to gravels with some sand and cobbles.

Of the 9.2 million cubic yards of fine-grained sediment trapped in both lakes, between 52 and 61% (4.8 million to 5.6 million cubic yards) would be eroded downstream from both dams. This fine-grained sediment would be transported in suspension and rapidly flushed down to the mouth where it would be dispersed by the strong currents in the strait. Based on numerical

Table 29. *Sediment Before and After Dam Removal — River Erosion (Proposed Action) (million cubic yards)*

	LAKE MILLS	LAKE ALDWELL	TOTAL
Fine-grained sediment (less than 0.75 mm) now	6.6	2.6	9.2
Fine-grained sediment released	3.6-4.1	1.2-1.5	4.8-5.6
Fine-grained sediment remaining	2.5-3.0	1.0-1.4	3.6-4.4
Coarse-grained sediment (larger than 0.75 mm) now	7.2	1.3	8.5
Coarse-grained sediment released	1.0-2.2	0.2-0.4	1.2-2.6
Coarse-grained sediment remaining	5.0-6.2	0.9-1.1	5.9-7.3

sediment modeling done by the Bureau of Reclamation, table 29 illustrates the percentage of coarse and fine-grained sediment predicted to erode from the reservoirs after dam removal.

The rate at which sediment would leave the reservoir areas would be a function of stream flow and the rate and timing of dam lowering. Because the Elwha River is relatively large and has a steep gradient, it is able to quickly move large quantities of sediment. Modeling (BOR 1995f) indicates that nearly all of the fine-grained sediment would move rapidly through the system, the sand would move more slowly, and the coarser materials would tend to aggrade the riverbed.

Monitoring of the erosion and downstream transport of sediment from the reservoirs during dam lowering would allow the lowering rate to be adjusted to prevent excessive riverbed aggradation and to facilitate water quality mitigation and fisheries restoration efforts. If necessary, dam lowering could be slowed or stopped to allow the river to "clean up" (become less turbid), allowing anadromous fish to enter the river.

During the first year of drawdown, sandy terrace materials that overlie fine-grained slower- draining lake sediments would frequently saturate, leading to rapid erosion and slumping. Channels would form in the slumped and eroded areas, and last over a period of days to weeks. In time, most of the erodible areas would have experienced enough wet conditions to erode, and progressively fewer channel bank slumps would occur. Vegetation would begin to stabilize the newly formed stream banks, terraces, and valley slopes; cobble bars would form in the active floodway. Over the short term (one to five years), upland landslides would be a minor sediment source compared to channel erosion within the reservoirs.

After dam removal, the sediment release from the reservoirs would depend on the timing and magnitude of flood flows. Two or three large spikes of suspended sediment concentration would be anticipated, and these would be likely to occur during the high flows of the first fall or winter after dam removal. Each progressively higher flood flow would cause some increment of channel widening. Sand, silt, and gravel terraces would remain along the valley like stair steps around the edges of the old reservoir. For Lake Mills, the terraces would remain between elevations 590 feet upstream to approximately 455 feet at the north end of the reservoir area. In Lake Aldwell, narrow terraces would remain in the wider alluvial portions of the reservoir. These new terraces would be located on the original alluvial valley terraces, between elevation 190 and 130 feet (BOR 1995f).

Around the very edge of the old reservoir areas, and above the deposition elevation of the delta sediments, would be an area of fine-grained silts and clay covering the old forest floor. The lakebottom sediments here are typically between 1 and 4 feet thick. On the steeper valley walls in the reservoir area, rain and surface erosion would wash these sediments onto sandy terraces or into the river.

Areas around the edges of the valley flats of the reservoirs might develop wetlands in isolated depressions and where valley wall seeps and springs meet the valley floor. Small tributaries would concentrate water at the valley wall edge and would incise a channel through the deposited and reworked reservoir sediments. Large logs might inhibit the erosion at the tops of small channels leaving additional wet grassy or wetland areas. For the most part, especially in the main channel, logs would have only a minor influence on the erosion rate of the river and its tributaries.

Long-term Restoration. The natural river processes and landscape of Krause Bottom upstream of Lake Mills are similar to how the reservoirs would look in the years following dam removal. Here, in the active channel areas, young plants sprout; sand, gravel, and cobbles are exposed. The stream banks are a tangle of roots and trees and eroding banks. Flood stage side channels form in the active floodplain.

The natural river processes and landscape of Krause Bottom upstream of Lake Mills are similar to how the reservoirs would look in the years following dam removal.

The river terraces in Krause Bottom were formed by the Elwha River as it incised down through the old glacial sediments deposited in the Elwha valley. Terraces similar to those in Krause Bottom are beneath the lakebottoms and delta sediments in both reservoirs. Terraces would form in the reservoir areas as the delta sands and gravels were eroded downstream.

Woody debris has concentrated on the reservoir deltas, at the base of the dams, and at other scattered locations in the reservoirs. Considerable amounts of smaller woody debris are expected on the reservoir bottoms, mostly twig to tree stump size material. Much of the finer-grained debris is waterlogged and would remain in the delta terraces along the reservoir, although some would float and wash downriver as the delta erodes. Stumps and logs would stay in-place except during floods, which would redistribute many logs and concentrate them along the flood bars. Logs also could jam in the canyons. Most log jams are passable by fish; some log jams could be modified to allow for complete fish passage.

Downstream Channels

Fine-grained sediment release. Between 1 and 3 million cubic yards of coarse-grained sediment and approximately 5 million cubic yards of fine-grained sediment would be released from the reservoir areas over a three-year period. Sediment concentrations in the river water would be relatively high during reservoir drawdown. Fine-grained sediment concentrations released downstream from the eroding deltas would initially be very low, then would progressively increase as the lake volumes reduced. For the first year of dam removal, water quality conditions would include months of high turbidity with concentrations in the range of 500 to 6,000 parts per million, and peaks could exceed 50,000 during high flows or drawdowns (see table 28).

Within one to three years, erosion rates from the reservoir areas would greatly reduce, approaching background levels within two to six years. Within two to six years after sediment release from the reservoirs, the percent of fine-grained riverbed sediments (less than 0.83 mm) in the middle and lower river substrate would return to more natural levels. Typical water quality following dam removal would include the natural upstream sediment supply that would normally range from 10 to 2,000 parts per million (based on water quality sampling upstream of Lake Mills; see Impacts to Surface Water section for more information). In the first years following dam removal as the reservoir areas recovered, the river would experience short periods of high sediment concentrations during high flow periods, with ambient water quality conditions most of the time.

Elwha River.
(Curtis Miller photo)

Vegetation would sprout quickly, both helping to control erosion and creating a natural landscape within one to six years (see appendix 3 for more information).

Aggradation of the riverbed (coarse-grained sediment release). Within two to six years after dam removal, return of the sediment supply to the downstream reaches would result in more sand and gravel in the channel sediments. Depending in large part on the slope of the river and the ability of the river to transport sediment, some sand and gravel would deposit on the riverbed, raising or aggrading the river in places. This could lead to more frequent flooding in some spots along the river. Also, as the sediment supply increased, the channel would migrate more often and over a wider swath of the floodplain.

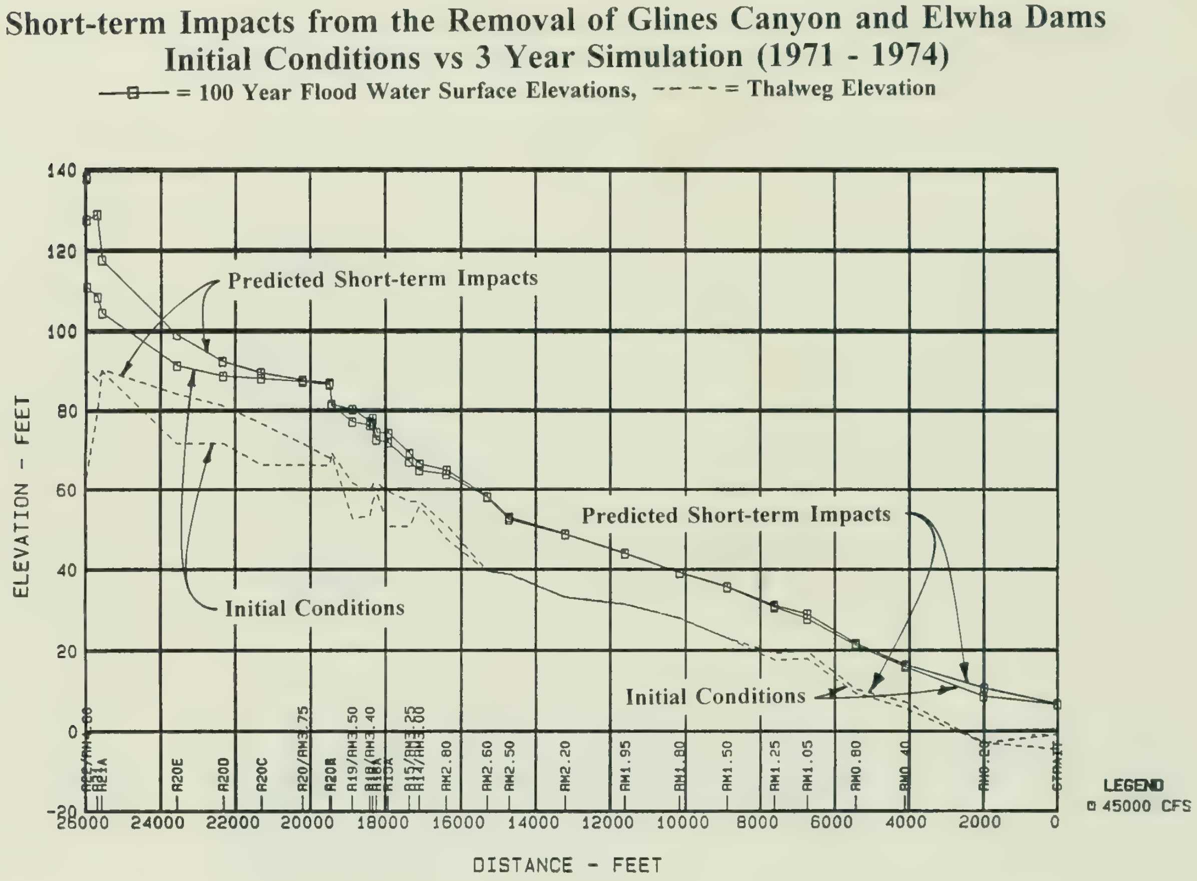
Because of the steep gradient in the middle reach of the river, coarse-grained sediment transport capacity would be higher than the expected sediment release rates from the Glines Canyon reservoir, and riverbed aggradation would not be expected to increase water surface elevations by more than 0.5 feet (BOR 1995f). For the first several years, sand and gravel would be expected to primarily fill pools. The majority of bedload sediments from the delta would move downstream in the two to four years following dam removal and river processes and channel characteristics would approach natural conditions in the middle reach within six years. Over the long term following removal of the dams, riverbed aggradation would be expected to increase the 100-year flood water surface elevations through the middle reach of the river by an average of up to 2.5 feet above current conditions. Although this increase would be a return to normal fluvial conditions, it could result in adverse impacts from flooding associated with increased surface water elevations (see Impacts to Flooding).

Coarse-grained sediment transport capacity of the lower reach (below Elwha Dam) would be lower than the expected sediment release rates from the reservoirs. Figure 20 is a profile view of the lower reach of the Elwha River showing the current thalweg (deepest part of the river channel), the thalweg after three years, the present river stage (water elevation), and the river stage predicted after three years. It illustrates that channel aggradation (deposition) would vary along the lower reach, and would generally be less in high gradient areas and greater in less steep areas and pools. Depending on the location in the river channel, 100-year flood elevations would increase 1 to 4 feet.

The predicted riverbed aggradation in the first mile downstream from Elwha Dam should be considered sediment storage rather than riverbed aggradation. Based on modeling, reservoir sediment erosion rates would be greater than the river's capacity to transport the sediments. In reality, sediments could not erode from the reservoirs at this rate, but would remain in and just downstream of the reservoirs until there was excess transport capacity in the river.

Figure 21 is a similar river profile with current conditions and predicted river stage after 50 years. This figure shows that, within 50 years, aggradation would

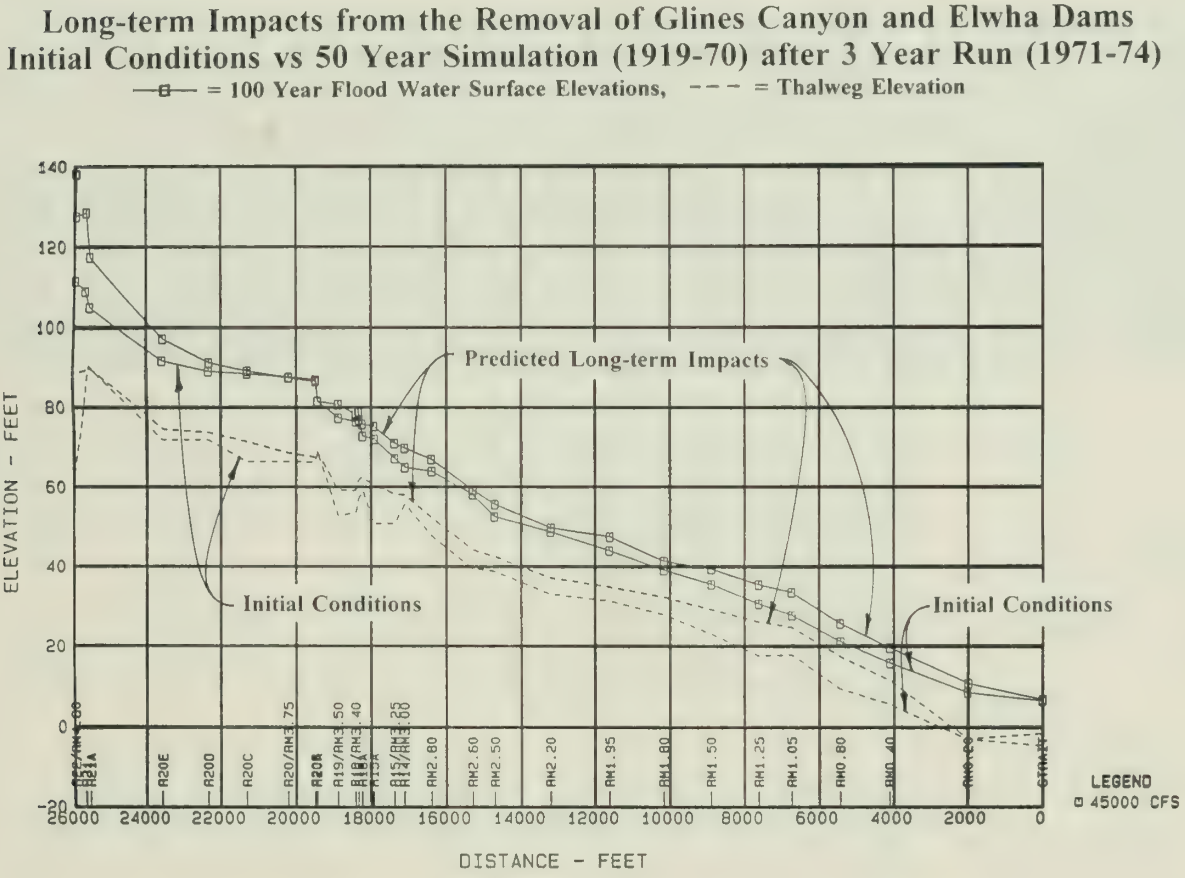
Figure 20. *Thalweg and Water Surface Elevations — Short-term Impacts*
SOURCE: Bureau of Reclamation, Lakewood, CO



Short-term Impacts from the Removal of Glines Canyon and Elwha Dams
Initial Conditions vs 3 Year Simulation (1971 - 1974)

—□— = 100 Year Flood Water Surface Elevations, - - - - = Thalweg Elevation

Figure 21. *Thalweg and Water Surface Elevations — Long-term Impacts*
SOURCE: Bureau of Reclamation, Lakewood, CO



Long-term Impacts from the Removal of Glines Canyon and Elwha Dams
Initial Conditions vs 50 Year Simulation (1919-70) after 3 Year Run (1971-74)
—⊡— = 100 Year Flood Water Surface Elevations, – – – = Thalweg Elevation

Elwha River delta. (Curtis Miller photo)

be more evenly distributed throughout the entire lower reach of the river. The change in river stage is also distributed throughout the entire lower reach. Coarse sediment redistribution would occur within 50 years; in fact, it would probably occur much sooner, depending on flow conditions (see Impacts to Flooding for more information).

The channel bars in the downstream reaches would have more sand and gravel deposited on top of them. Because of the increased coarse sediment transport rates during and following dam removal, the channels would be more active and more side channels would form.

Coastal delta area and beaches. During dam removal, the river's transport capacity would determine how much sediment would be carried to the mouth. Between one and three million cubic yards of coarse grained sediment and 5 million cubic yards of fine-grained sediment could move through the river in an estimated 3 years time compared with annual natural sediment transport rates for the Elwha of between 100,000 and 500,000 cubic yards per year. This is comparable to what much larger rivers, such as the Fraser and Skagit combined, would discharge into northern Puget Sound (Feely and Lamb 1979). The Elwha River would intermittently deliver sediment to the coast for three to four years at about the same amount as these large rivers.

Sediment deposited at the river mouth, with additional sediment from the coastal zone and bluffs, would be moved by waves and tidal currents along the coast and into deeper waters by currents in the Strait of Juan de Fuca to reestablish a natural beach and coastal estuary system. Within one to two years, the newly forming river mouth bars would be dispersed up to a mile farther along the coast, and within five to ten years would be contributing additional sediment to Ediz Hook. The coast would look much the same as it does now, except there would be additional sand on the beaches and nearshore areas. The wetlands behind the beach would remain in some form, and additional wetlands and backwater channels would grow and change at the river mouth (see Impacts to Living Marine Resources). Sediment deposition near the river mouth would result in increased water elevations in the lower river. For a description of these changes, see Impacts to Flooding section.

The fine-grained sediment would remain in suspension and be distributed in a plume into the strait. The bedload sediment arriving at the river mouth would expand the Elwha delta and stop the gradual recession of the beach zone there. As the sands and gravels that deposited at the mouth redistributed along the coast, the recession rate of the coastal bluffs might be slightly reduced due to the presence of more beach sediment. The sediment supply to Ediz Hook would be increased by an estimated 35%.

Any number of channel configurations would form at the river mouth as more sediment returned to the lower river. Typically, during large floods, a large amount of sediment is shifted about within a few days time. The floods deposit the sands and gravels as bars 100 to 500 feet in size at the river mouth. Channels are continuously eroded in these bars by the river, waves, and tidal currents. The flood waters spread the sediment into side channels and onto terraces, especially the sand and coarse silt that is aggressively transported during floods. The stream gradient is lowest at the river mouth, and the wide floodway and high tide backwater creates flooded areas where sand and silt would deposit during dam removal. Natural levees of sand and gravel would deposit along the channel edges. Sands and gravels would deposit on the main bars and overbank areas, and fine-grained sediment would deposit in the quieter backwater areas creating wetlands.

...the proposed action could be accomplished without substantial aggradation downstream and without dredging or other extensive mechanical intervention.

Cumulative Impacts

The increased sediment transport rates during and for several years following dam removal would be in addition to the natural sediment supply rates from the upper Elwha basin. The combined supply rate of sediment would lead to increased channel storage of sediment along the channel, causing channel aggradation and increased volumes of flood deposits on the flood terraces along the channels. Within one to three years following dam removal, the release of stored sediment from the reservoirs would rapidly decrease and begin approaching the natural supply rates moving downriver. Long-term aggradation downstream from the dams resulting from transport of the natural sediment supply would be expected to increase the 100-year flood water elevations by up to 4 feet at some locations, although, typically, the increase would be about 2 feet.

Conclusion

Between 1.2 and 2.6 million cubic yard of fine-grained sediment and 4.8 to 5.6 million cubic yards of coarse grained sediment would erode from the reservoirs following dam removal. Fine-grained sediment would move repidly downstream, approaching background levels in two to six years. In some areas, the riverbed would aggrade, causing increased water surface elevations of up to 4 feet. Dam removal would restore a more free–flowing river with more meandering over its floodplain and increased bank erosion. Reestablishing the downstream sediment supply would cause rebuilding of the beaches and offshore delta within three years and contribute sediment to Ediz Hook within five to ten years.

Controlling the rate of dam removal and the rate of release of sediments from the reservoirs, the proposed action could be accomplished without substantial aggradation downstream and without dredging or other extensive mechanical intervention. Intermittently for two to three years, the plume of suspended sediment from the Elwha would be similar to that of the Fraser or Skagit rivers — much larger rivers discharging into Puget Sound.

Impacts of the Dredge and Slurry Alternative

Use of a dredge and slurry pipeline would not completely remove all fine-grained sediment from the reservoirs during dam removal. Material trapped in the deltas of both lakes, approximately 2.4 million cubic yards of fine-grained sediment, would not be accessible to dredges; a portion of it would erode downstream with the coarser-grained materials (table 30). Physical limitations of dredging equipment, especially in lake bed areas of logs and tree stumps, would also leave some fine-grained sediment in the reservoirs. The remaining fine-grained sediment would be covered by the eroding delta sediment, to later erode and wash downstream. Erosion of the fines that are mixed with the coarser-grained deposits in the deltas would increase suspended sediment concentrations downstream when coarse material eroded during and following dam removal.

Table 31 illustrates the dam removal scenario for the Dredge and Slurry alternative, the expected concentrations, and duration of suspended sediments released during and after dam removal.

Table 30. *Fine-grained Sediment Behind Dams and Quantities Expected to Enter River upon Dam Removal — River Erosion (Proposed Action) and Dredge and Slurry Alternatives (million cubic yards)*

	LAKE MILLS	LAKE ALDWELL	TOTAL
Fine-grained sediments (less than 0.75 mm) present now	6.6	2.6	9.2
Proposed Action- fine-grained sediments washed out by river erosion	3.6-4.1	1.2-1.5	4.8-5.6
Dredge & Slurry- fine-grained sediments washed out by river erosion	0.9-1.0	0.35-0.4	1.2-1.4

Conclusion

Erosion of coarse-grained sediment would be the same as the proposed action. Fine-grained sediment concentrations eroding from the delta initially would be the same as with the proposed action. Suspended sediment concentrations in the river during dam removal would be approximately 25% of the amount of the proposed action because about 75% of the fine-grained sediments would be removed with the dredging operation.

Table 31. *Range of Final Sediment Release During and Following Dam Removal — Dredge and Slurry Alternative*

SOURCE OF IMPACT	TIME OF IMPACT	SUSPENDED SEDIMENT CONCENTRATIONS AND DURATION
Begin lake drawdown for dam removal	Starting in June, year 1	41 to 81 days less than 200 ppm[a] 79 to 179 days more than 200 ppm 7 to 76 days more than 1,000 ppm 0 to 1 day more than 10,000 ppm 1,700 to 11,000 ppm peak concentration
Stop dam removal during winter floods and to protect migrating fish	Starting in November, year 1	20 to 119 days less than 200 ppm (close to background levels)
Continue dam removal after winter floods	Starting between December, year 1 and February, year 2	0 to 36 days less than 200 ppm 20 to 84 days more than 200 ppm 12 to 38 days more than 1,000 ppm 0 days more than 10,000 ppm 1,400 to 2,700 ppm peak concentration
Stop dam removal during high spring runoff and to protect migrating fish	Starting in April or May, year 2	96 to 100 days less than 200 ppm (close to background levels)
Complete dam removal after high spring runoff	Starting in July and lasting to late October, year 2	1 to 6 days less than 200 ppm 88 to 108 days more than 200 ppm 22 to 61 days more than 1,000 ppm 0 to 1 day more than 10,000 ppm 3,900 to 13,000 ppm peak concentration
Flood induced erosion following dam removal	Starting November, year 2 through September, year 4	625 to 708 days less than 200 ppm 5 to 84 days more than 200 ppm 4 to 13 days more than 1,000 ppm 0 days more than 10,000 ppm 5,300 to 9,400 ppm peak concentration

[a] Parts per million (ppm) by weight.

Flooding

Summary of Regulations

Executive Order 11988 (Floodplain Management) directs each federal agency to "provide leadership and take action to reduce the risk of flood loss, to minimize the impacts of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains." The *National Park Service Floodplain Management Guidelines* (Special Directive 93-4, August 11, 1993) specifies requirements for carrying out EO 11988 in national parks. Floodplains that are subject to regulation by the executive order and the guideline include the 100-year floodplain, 500-year floodplain, and extreme floodplain.

National Park Service Management Policies (1988a) require that the occupancy and modification of floodplains should be avoided wherever possible. Where no practicable alternatives exist, mitigating measures will be implemented to minimize potential harm to life, property, and the natural values of floodplains. The *National Park Service Management Policies, Special Directive 93-4* (Floodplain Management Guideline), *NPS-2* (Planning Process Guidelines), and *NPS-12* (NEPA Guideline) provide specific direction on developments proposed in floodplains within national parks.

State regulations that affect development activities in and near floodplains and wetlands include the Shoreline Management Act, State Hydraulic Code, the State Water Pollution Control Act, and the Floodplain Management Program. The Shoreline Management Act was passed to manage appropriate uses of Washington's shorelines. The State Hydraulic Code is intended to protect fish from damage by construction and other activities in all state waters; it is carried out through a Hydraulic Project Approval obtained from the Washington Department of Fish and Wildlife. Hydraulic Project Approval is required for any work within the high water areas of state waters. Washington state's Floodplain Management Program establishes statewide authority for floodplain management through the adoption and administration by local governments of regulatory programs compliant with the minimum standards of the National Flood Insurance Program. See appendix 6 for a listing of additional permits that are required for this project.

Methodologies for Analyzing Impacts

The focus of this section is on possible damage from flooding. (Impacts to resources in floodplains have been assessed under other sections in this document — fluvial processes, surface water, groundwater, and cultural resources). The effects of riverbed aggradation for the action alternatives were analyzed by the US Bureau of Reclamation through computer modeling. The US Army Corps of Engineers assessed impacts to flood control levees, roads, wells, private property, and other structures based on the riverbed aggradation analyses.

The primary impact analyses for resources in the 100-year floodplain of the Elwha River and its tributaries were completed using HEC-2 numerical computer models. HEC-2 is a one-dimensional, standard-step method model that computes a steady-state water surface profile. The model requires cross sections, water discharge rates, and energy loss coefficients (boundary roughness, channel platform, and expansion/contraction) as input parameters. Accuracy of the computed water surface profiles and delineation of the flooded area are dependent upon survey accuracy, the distance between the cross sections, the gradient of the river, and the knowledge of the energy loss coefficients.

Two separate HEC-2 models were developed to assist in the flooding impacts evaluation. One model extended for the 5-mile reach from the mouth of the river to Elwha Dam, and the other from the US Highway 101 bridge (near the upstream end of Lake Aldwell) to Glines Canyon Dam. In addition, HEC-6 transport modeling was done by the US Bureau of Reclamation (BOR 1995f) to predict the impact of dam removal on river channel geometry and water surface elevations from the river mouth to Elwha Dam. Due to limitations in topographic data, the computed design discharge water surface elevations for the reach above Lake Aldwell are significantly less accurate than for the downstream area. A detailed sediment transport analysis through the middle reach of the river similar to that for the reach downstream of the Elwha Dam was not done because of insufficient channel cross-section data for the rugged area between the two dams. A more complete description of the HEC-2 modeling results can be found in appendix 4.

...the only flood protection provided by the dams is during short-duration storms or periods of snowmelt.

Impacts of No Action

Both Elwha and Glines Canyon dams are operated in a "run-of-the-river" mode, which means that the reservoir level is held constant and very little of the water entering the drainage is stored or released differently from the way it was before the dams were built. Because of dam operations, and the small storage volume in the reservoirs, the only flood protection provided by the dams is during short-duration storms or periods of snowmelt. The homes, wells and cultural resources that would be affected by periodic flooding lie within the 100-year floodplain and are susceptible to flooding now. This is a potential major adverse impact of the No Action alternative to those property owners.

Flooding now occurs along parts of the Elwha River (see figure 9, table 32, and appendix 4), but at a lower elevation than before the dams were built. This is because sediment transport of coarse-grained materials was stopped by the dams, and most of the riverbed material (sand and gravel) downstream from the dams has long ago washed out to sea. Very little coarse-grained sediment enters the middle and lower reaches of the Elwha River; the only sources now are from tributaries, landslides, and erosion of material along the banks of these reaches.

Because of the lack of a coarse sediment supply to the middle and lower reaches of the river, sections of the riverbed have degraded or lowered, and the water surface elevation has lowered with it. The water elevation associated with a given flood-flow rate is therefore lower than when the riverbed was at a higher elevation. The degree of degradation varies from Glines Canyon Dam to the mouth of the river, and is generally more obvious in less steep sections such as in the lower reach. This reduced flooding risk is a minor, beneficial impact for property owners along the Elwha River.

The armoring or channeling (see Fluvial Processes, Affected Environment section) associated with the loss of bedload material in some cases has also reduced the width and amount of the river's meander. There is slightly less chance of flood damage to property near the river now as a result of these changes.

However, the health of the river's ecosystem is dependent on the natural flood stages of the river. Wetlands and backwater areas such as pools and side channels are rare in the middle and lower reaches because the river does not meander as much as before the dams were built (see Sediment, Fisheries, and Vegetation Impacts of the proposed action). Also, reduced channel meandering and lateral adjustment result in fewer sites for regeneration of riparian vegetation — causing a more mature and less diverse riparian zone.

The structures, levees, wells, and roads listed in table 32 are located within the 100-year floodplain of the Elwha River.

Conclusion

The dams are currently operated in a natural flow or run-of-the-river mode, and homes, wells, and cultural resources are periodically flooded; this is a potential major impact of the No Action alternative. Degradation of the riverbed, caused by trapping coarse-grained sediment behind the dams, has caused flood stage from Glines Canyon Dam to the mouth of the river to be lowered. These are minor beneficial impacts for property owners and adverse impacts to the river's ecosystem (fish, plants, animals, sediment distribution). These conditions would continue if the dams are not removed.

Impacts of the Proposed Action – River Erosion Alternative

With the proposed action there would be no change in stream volume and flow rate after dam removal because both dams have historically been operated in the run-of-the-river mode and there is very little floodwater storage capacity in the reservoirs (BOR 1995e). However, dam removal would result in deposition and build up (aggradation) of coarse-grained sediments (sand size and larger) downstream of the dams. Generally, more sediments would be deposited resulting in more aggradation in areas with gradual stream gradients than in steeper sections of the river. Increases in river stage in most sections of the river would not exceed 4 feet and would average 2 feet over the entire river (see figures 20 and 21). These increases in river stage may cause more

Table 32. *Elwha River Valley Structures and Existing Flood Conditions for the 100-year Frequency Flood Event*

STRUCTURE	RM	EXISTING FLOODING CONDITIONS
Lower Elwha federal flood control levee (east bank)	0.1-1.6	Protection for up to 200 yr. flood
Locally constructed privately owned levee (west bank)	0.0-0.1	Protects 30 acres of land for 25 to 50 yr. frequency flood
Private residences	0.0-0.2	10 structures experience backwater flooding with a 200 yr. flood
Elwha Place Homeowners' wells	1.4	2 EPHA wells and private residence and private well are 2 ft. below the 100 yr. frequency flood elevation
City of Port Angeles Ranney well collector	2.8	Well caisson and chlorination building are at the 100 yr. flood elevation
WA State fish rearing facility	2.8-3.0	Shallow nuisance type flooding occurs with a 100 yr. flood
Port Angeles industrial water supply channel	2.8	Protected from the 100 yr. flood by an access road
Water wells at the fish rearing facility	2.8	Lies below the 100 yr. flood level
West bank private residences	3.5	3 structures and associated private wells are 2 to 3.5 ft. below the 100 yr. frequency flood elevation and are flooded by about a 10 to 30 yr. frequency flood
East bank private residences	3.5	Residence and well are 2 ft. below the 100 yr. flood level and are flooded by a 10 to 20 yr. frequency flood
Dry Creek Water Association wells and access road	3.6	Floor elevation of 2 well houses at the 20 to 50 yr. flood frequency. Access road flooded by a 10 yr. flood. Highest well above 100 yr. frequency flood elevation
Private well	7.9	Situated near the confluence of the Little and Elwha rivers, the well lies 2 to 3 feet below the 100 year flood level
Private residences - east bank	8.4	3 structures flooded by 5 to 10 yr. flood
River training dike	8.5	Does not offer flood protection but redirects high velocity flows. Flooded by the 25 yr. flood
Private residence - east bank	9.5	Residence and well are 1.5 feet below the 100 yr. frequency flood elevation
Elwha Campground	11.0	Campground and well are below 100 yr. flood level and currently floods at less than 5 yr. frequency
Elwha Ranger Station	12.0	2 ft. above the 100 yr. frequency flood elevation
Altaire Campground	12.5	Partially flooded by annual floods. Flooded by as much as 8 ft. during 100 yr. flood
Olympic Hot Springs Road (Elwha Valley Road)		1 mi. outside park and 3500 ft. inside park are below the 100 yr. frequency flood elevation
Bridges		None are affected by high water levels or floating woody debris during flood events

Source: COE, 1995a.

frequent flooding of some areas along the river. Fine-grained materials would pass through the river system and would not be deposited in the Elwha River channel (BOR 1995f).

Increased bank erosion and lateral migration of the river would be expected following dam removal as a result of sediment deposition in the river channel. Because of the large number of hydraulic variables and the dynamic nature of the river system, it is not possible to exactly predict the amount and locations of changes in the floodplain. The river may meander over the entire floodplain in any given area, and would change course more frequently than it does now. As it moves closer to structures, river banks or cultural sites, these areas could be eroded or damaged.

The increase in water surface elevation and flooding subsequent to dam removal would be classified as short-term (up to 3 to 5 years following dam removal) or long-term (up to 50 years and beyond). Short-term impacts are

Table 33. *Water Surface Elevations Before and After Dam Removal with the 100-year Frequency Flood Event.*

RM		EXISTING WATER SURFACE ELEVATION	PREDICTED WATER SURFACE ELEVATION - LONG-TERM	INCREASE (feet)
0.1	**Federal levee - downstream end**	7.4	8.4	1.0
1.4	**Elwha Place wells**	32.1	35.4	3.3
1.6	**Federal levee (upstream end)**	34.9	38.1	3.2
2.8	**Washington State Fish Rearing Facility, Ranney collector**	64.2	66.7	2.5
3.3	**Route 112 bridge**	76.0	77.9	1.9
3.3	**Industrial water intake**	77.6	79.5	1.9
3.5	**Private residences**	78.4	80.2	1.8
3.6	**Dry Creek Water Association wells**	83.3	84.6	1.3
4.9	**Elwha Dam**	109.7	111.5	1.8
7.7	**Hwy 101 bridge**	207.8	210.3	2.5
7.9	**Private well**	210.4	212.8	2.4
8.5	**USGS gauging station**	232.1	234.5	2.4
9.6	**ONP boundary**	258.9	260.3	1.4
11.0	**Elwha Campground**	325.0	326	1.0
12.0	**Elwha Ranger Station**	351.3	352.1	0.8
12.5	**Altaire Campground & bridge**	368.5	371.0	2.5

SOURCE: COE, 1995a

directly related to release of the sediment stored behind the dams. Long-term impacts would result from restoring the river's natural sediment supply. Short-term impacts would be somewhat regulated by the rate at which the dams were removed, while long-term impacts, governed by natural sediment processes, could not be controlled (BOR 1995f; COE 1995a; Randle and Lyons 1995). Over the long-term (up to 50 years and beyond), aggradation caused by deposition of coarser-grained sediments would be greater than that caused by the short-term (up to five years) release of sediments from behind the dams.

With the exception of the Elwha Ranger Station in Olympic National Park, the structures in table 32 lie within of the current 100-year floodplain. As a result of the proposed action, various roads, levees, wells, and structures currently in the 100-year floodplain would be flooded more frequently. This would be a major adverse impact but would not be significantly different than existing conditions.

The impacts from sediment aggradation attributable to the release of sediment from the reservoirs after removal of the dams are expected to be less than the long-term impacts without mitigation, so all impact discussions focus on long-term impacts and represent the worst case flooding scenario. Below is a brief discussion of site-specific long-term impacts based on the HEC-2 modeling for the 100-year flood event, beginning at the mouth of the river and going upstream to Glines Canyon Dam. All of these impacts can be avoided or compensated for with the mitigation that is recommended in table 34.

Lower Elwha federal flood control levee river mile 0.1 - 1.6
The lower Elwha flood control levee (also referred to as the federal levee) was built to protect up to the 200-year flood event. With removal of the dams, the water level would increase from 1.0 to 4.0 feet. One thousand feet of the levee would need to be raised an average of 3 feet and armored with 2-foot thick riprap to retain the current level of flood protection.

Locally constructed (nonfederal) levee river mile 0.0 to 0.1
A 900-foot levee extending from the mouth of the Elwha River to the bluff on its west bank provides protection for 25- to 50-year frequency floods for approximately 30 acres on the west bank. After dam removal, any structures currently protected by this levee would be flooded more often and flood water elevations would be higher.

Private residences near the downstream end of the federal levee river mile 0.0 to 0.2
Ten structures near the mouth of the Elwha in the Lower Elwha Klallam Reservation presently experience backwater flooding in a 200-year flood. Aggradation of the riverbed and an increase in the water level surface after dam removal could cause additional flooding of these ten structures and another five structures situated landward of the federal levee.

Elwha Place Homeowners' wells river mile 1.4
Two domestic water supply wells and a private residence located on the west overbank of the Elwha are now approximately 2 feet below the 100-year frequency flood elevation. Increased water elevations after dam removal would result in more frequent flooding of the residence and wells.

City of Port Angeles Ranney well collector river mile 2.8
The well caisson and chlorination building for the city's Ranney well located on the east bank of the river is at the current 100-year frequency water surface and following dam removal would be flooded with the 100-year flood.

Washington State rearing facility river mile 2.8 to 3.0
Currently, only very shallow nuisance type flooding of the facility's ponds is likely to occur during a 100-year flood. Following dam removal, the fish rearing facility would be covered by approximately 2 feet in a 100-year flood.

Port Angeles industrial water supply channel river mile 2.8
Currently protected from the 100-year frequency by an access road, this channel would be flooded by the 100-year flood after dam removal.

Water wells at the fish rearing facility river mile 2.8
The well field located between the fish rearing ponds and the river, upstream from the fish rearing facility lies below the 100-year flood level. After dam removal, the wells would be flooded by an additional 2.5 feet of water during a 100-year flood event.

West bank private residences near river mile 3.5
Three residential structures on the west bank of the river, now 2 to 3.5 feet below the 100-year flood elevation, are presently flooded at 10- to 30-year frequencies. Riverbed aggradation following dam removal would increase the 100-year water surface elevation 1.5 to 2 feet and the frequency at which these homes are flooded to 5 to 15 years.

East bank private residence near river mile 3.5
A residential property on the east bank of the river near the Dry Creek Water Association wells is approximately 2 feet below the 100-year flood level and currently floods at 10- to 20-year frequencies. After dam removal, flooding would increase to an estimated five to eight years with a 1.5-foot increase in the 100-year flood water elevation.

Dry Creek Water Association wells and access road river mile 3.6
Four wells maintained by the Dry Creek Water Association are located on the east bank of the Elwha River. The floor elevations of the two well houses are at the 20- to 50-year flood; they would be flooded more frequently and with higher water elevations as a result of dam removal. The access road to the wells, flooded now at a 10-year flood frequency, also would flood more often. The highest well is now above the 100-year flood frequency elevation but, due to sediment aggradation after dam removal, would be flooded by the 100-year flood.

Private well near river mile 7.9
Private well located near the confluence of the Little and Elwha rivers, lies 2 to 3 feet below the current 100 year frequency flood elevation. Sediment aggradation near the wellhead is expected to be 2.4 feet following dam removal, causing more frequent flooding with higher water elevations.

Private residences near river mile 8.4
Three residential properties on the east bank of the river, 3 to 7 feet below the 100-year flood level, are flooded on a 5- to 10-year frequency. These structures would flood more often and with higher water elevations if the dams are removed.

River training dike river mile 8.5
A 300-foot training dike near river mile 8.5 does not offer any flood control protection but does redirect high velocity flows away from the Elwha Valley Road (Olympic Hot Springs Road) embankment. It is now flooded by a 25-year frequency flood and would be flooded more often if the dams are removed.

Private residence near river mile 9.5
Located just downstream from the park boundary on the east bank of the Elwha River and situated 1 to 1.5 feet below the 100-year flood event is a residential property that now floods at a 25-year flood. If the dams are removed, this property would be subjected to more frequent and higher water elevation flooding and possible bank erosion.

Elwha Campground river mile 11
The Elwha Campground lies below the 100-year flood level and currently floods at less than a 5- year flood. If the dams are removed, there could be an increase in water surface elevation of approximately 1 foot, which would cause more frequent flooding.

Elwha Ranger Station river mile 12
The Elwha Ranger Station structures are located approximately 2 feet above the 100-year frequency flood elevation. If the dams are removed, with an increase in water surface elevation of an estimated 1 foot, they would still be above the 100-year flood elevation.

Altaire Campground river mile 12.5
Altaire Campground is partially inundated during annual floods and could flood by as much as 8 feet during a 100-year event. Flooding would increase by 2 to 2.5 feet if Glines Canyon Dam is removed.

Elwha Valley Road (Olympic Hot Springs Road)
Elwha Valley Road parallels the Elwha River (on its east bank) from Highway 101 to Glines Canyon Dam. Four sections of the road (two areas inside the park boundaries totaling 1 mile and two outside the park totaling 3500 feet) currently flood at frequencies of less than 100 years. These areas would flood more often and with higher water elevations after dam removal.

Highway 112 bridge over the Elwha River. (Charles Scott photo)

Bridges

After dam removal, water flow under four bridges — the Elwha Valley Road near the fish rearing facility, Highway 112 near river mile 3.3, US Highway 101 near river mile 7.7 and Elwha Valley Road near Altaire Campground near river mile 12.6 — would not be significantly affected by aggradation-induced higher water surface elevations. Increased volumes of woody debris floating down the river could affect the in-water piers of the Highway 101 and Altaire Campground bridges.

Mitigation

Table 34 identifies mandatory and recommended structural mitigation for all buildings, wells, roads, and bridges that may be affected by the removal of Glines Canyon and Elwha dams. Mitigation required by the Elwha River Ecosystem and Fisheries Restoration Act to ensure the protection of municipal and industrial water supplies, (including the City of Port Angeles, Dry Creek Water Association wells, and the Lower Elwha Klallam Tribal Fish Hatchery) would be built into both of the action alternatives. Before the dams are removed, the Lower Elwha Federal Flood Control Levee would be raised and strengthened to maintain the current 200-year flood protection. Other mitigation not required as part of the Elwha Act but recommended in this EIS is also included in table 34. When implemented, it would provide the same level of flood protection that now exists for these structures.

Various nonstructural measures could also mitigate for flooding impacts. Flood insurance could be provided to individuals subjected to more frequent flooding after dam removal. Properties could be purchased from owners so that they could relocate away from the Elwha River.

Cumulative Impacts

There has always been a danger of flooding by the Elwha River, even with both dams in place. Many structures within the present 100-year floodplain currently have the potential to be inundated by the Elwha River, since both Glines Canyon and Elwha dams are operated in a natural flow or run-of-the-river mode. The threat of periodic flooding at some locations would increase (as would bank erosion) following dam removal.

Conclusion

Riverbed aggradation and raising of the water surface elevation up to 4 feet between Glines Canyon Dam and the river mouth would cause more frequent flooding at some locations, causing major adverse impacts, although not significantly different than existing conditions. Short-term flooding impacts from dam removal are less than the long-term effects from reestablishing natural river processes. Maintaining the 200-year level of flood protection now provided by the Lower Elwha Federal Flood Control Levee, and requirements of the Elwha Restoration Act to protect municipal and industrial water users from adverse impacts of dam removal are assumed. Additional mitigation,

Table 34. *Structural Mitigation for Flooding Impacts.*

LOCATION AND STRUCTURE	MITIGATION
Lower Elwha flood control levee- RM 0.1-1.6	raise levee an average of 3 feet and armor with 2 foot thick riprap (required)
Locally constructed (nonfederal) levee - RM 0.0 - 0.1	raise levee 1 foot and armor with 2 feet of graded riprap
Private residences - RM 0.0 - 0.2	raise structures by 1 foot or flood proof / extend federal levee to high ground
Elwha Place Homeowners' wells and private residence - RM 1.4	raise wellheads and residence up to 3 feet
City of Port Angeles Ranney well collector - RM 2.8	raise well caisson and chlorine storage building 3 feet or protect with levee (required)
Washington State fish rearing facility - RM 2.8 - 3.0	raise 3,000 feet of Crown Zellerbach Road by 5 feet (immediately west of facility) and add flap gate to entrance channel culvert
Port Angeles industrial water supply channel - RM 2.8	raise Crown Z Road as above (required)
Water wells at fish rearing facility - RM 2.8	raise wellheads 3 to 4 feet
West bank residences - near RM 3.5	raise structures or floodproof
East bank residence - near RM 3.5	raise structures or floodproof
Dry Creek Water Association wells and access road - RM 3.6	raise road grade 1.5 - 6 feet, raise 2 well houses and 1 exterior wellhead (required)
Residences - near RM 8.4	raise 2,000 feet of the Elwha Valley Road (Olympic Hot Springs Road) by 3.5 feet and raise or floodproof 3 houses
River training dike - RM 8.5	raise dike 3 feet and armor with riprap
Residence - near RM 9.5	raise structures or floodproof; armor channel bank with riprap 15 feet high and 3 feet thick
Elwha Campground - RM 11	close campground during high flows or relocate campground if suitable areas outside floodplain are available
Elwha Ranger Station - near RM 12	none necessary
Altaire Campground - RM 12.5	close campground during high flows or relocate campground if suitable areas outside floodplain are available
Elwha Valley (Olympic Hot Springs) Road - 4 miles long	raise about 1 mile of low elevation sections of the road by 1.5 feet (in park); raise 2/3 mile of road outside of park by 1.5 to 2.5 feet. Riprap select sections of road
Bridges: U.S. Highway 101 - near RM 7.7 Elwha Valley Road - near Altaire Campground at RM 12.6	add debris deflectors to the in-water piers

Source: COE, 1995a.

although not mandated by the Elwha Act, has been recommended in this EIS to protect other structures that would be adversely impacted by flooding.

Impacts of the Dredge and Slurry Alternative

The impacts of the slurry pipeline alternative would be the same as the proposed action and are summarized in the following paragraphs. Dredging and slurrying the finer-grained sediments from behind the dams would have no effect on the frequency of flooding downstream, because it is the coarse-grained sediment that deposits and aggrades the river channel. Since coarse-grained sediments from the reservoir deltas would be eroded by the river, the potential for downstream flooding would be the same as for the proposed action.

Short-term flooding impacts from dam removal are less than the long-term effects from reestablishing natural river processes.

As with the proposed action, some areas in the lower Elwha River may flood more frequently as a result of riverbed aggradation and raising of the water surface elevation. Based on mathematical modeling, short-term flood impacts from dam removal would be less than the long-term effects from reestablishing natural river processes in the Elwha River. Depending on where a structure is located within the Elwha River floodplain, there would be minor to major impacts caused by more frequent flooding when the dams are removed. There would be no effect to the streamflow in the river (hydrologic regime). Restoring a coarse-grained sediment supply to the river would result in its meandering over more of the floodplain and would have the beneficial impact of reestablishing natural fluvial processes. Conversely, such meandering could increase bank erosion and may cause property damage along the river.

Conclusion

The dredging and slurrying of fine-grained sediments would have the same flooding impacts as the proposed action. Riverbed aggradation and raising of the water surface elevation up to 4 feet between Glines Canyon Dam and the river mouth would cause more frequent flooding at some locations, causing minor to major adverse impacts. Short-term flooding impacts from dam removal are less than the long-term effects from reestablishing natural river processes. In maintaining the 200-year level of flood protection with the Lower Elwha Federal Flood Control Levee, and protecting municipal and industrial water users from adverse impacts of dam removal, requirements of the Elwha Restoration Act would be provided. Additional mitigation, although not mandated by the Elwha Act, has been recommended in this EIS to protect other structures that would be adversely impacted by flooding.

Surface Water

Summary of Regulations and Policies

The Clean Water Act controls discharge to waterways and the dredge and fill of wetlands. The permits required to discharge to waterways are obtained from the Washington Department of Ecology (NPDES permit), and to fill wetlands, from the US Army Corps of Engineers (Section 404 permit).

The Safe Drinking Water Act controls requirements and standards for public drinking water supplies.

The Washington Department of Ecology (WAC — Washington Administrative Code — 173-201A) establishes water quality standards for surface waters consistent with public health and enjoyment, and the propagation and protection of fish, shellfish and wildlife. The Department of Ecology also controls water withdrawals by issuance of water rights for the state of Washington.

The Elwha Restoration Act, Public Law 102-495 provides for protection of existing quality and availability of water from the Elwha River for municipal and industrial uses from possible adverse impacts of dam removal.

Methodologies for Analyzing Impacts

The impacts to both the surface water quality and surface water users are analyzed in this document. The primary surface water users are industrial customers (mills) served by the city of Port Angeles, the Washington State fish rearing facility and the Lower Elwha Tribal Fish Hatchery.

The Elwha River would erode sediment deposited behind the dams and transport that sediment downstream during and following dam removal along with natural sediment sources from above Lake Mills. The natural load of dissolved and suspended sediment from above Lake Mills, minus the percentage of the natural load not trapped by the reservoirs, plus the additional loading due to erosion of the accrued lake bed sediment represents the total impact to water quality. The difference was measured both in terms of quantity and quality of additional solids loading.

Those who use Elwha River water and hold surface water rights are the city of Port Angeles, which supplies water to the Washington Department of Fish and Wildlife facility, Daishowa and Rayonier mills via a check dam diversion at river mile 2.8, and the Lower Elwha Klallam Tribal Fish Hatchery (many others hold groundwater rights — see Groundwater section for more information). Without mitigation, these users, as well as in-stream fish and other aquatic life, would be adversely affected by the changes in surface water quality during and briefly after dam removal. Analysis indicates the primary impacts would be from increases in suspended and dissolved solids.

User and fisheries requirements were considered in assessing impacts to water quality. Mill and fisheries data indicate that total suspended solids and total dissolved solids, including identification of dissolved constituents, turbidity, temperature, and dissolved oxygen are the most critical surface water quality impact indicators.

Surface water impacts are assessed by collecting records of these critical and other key water quality indicators, and predicting their values under each action alternative by modeling and calculations based on assumed quantities, research, data and experience. Then historic, current, and predicted future values were compared to each other and to applicable water quality standards and mill requirements. A chemical analysis screening for relative organic compounds, pesticides, radio nuclides, and a suite of metals indicated iron, manganese, pH, and total organic carbon were important indicators in addition to turbidity and temperature. Data would continue to be collected through a monitoring program by the US Geological Survey. The current monitoring program includes a new (1994) water data collection station above Lake Mills. A new station is proposed below the Elwha Damsite.

Impacts of No Action

Discharge

Since the dams are operated in a "run-of-the-river" mode, river flows are little different from pre-dam conditions.

Lake Aldwell from Highway 101. (Maggi Johnson photo)

Use

The city of Port Angeles drinking supply is obtained via a Ranney collector. The water is naturally filtered by the riverbed sand and gravel; it is chlorinated and needs no other treatment. Industrial users vary their treatment level according to individual mill requirements, but generally need to treat intensively only during high flow, high turbidity periods.

Water Quality

The Elwha River reservoirs act as large settling basins, removing all of the coarse sediment and some of the fine sediment that is transported from upstream. Because of this, water is on average slightly less turbid downstream than above the dams, a minor to moderate beneficial impact on water quality. This difference is magnified following high flow events (see table 35 below). Although water downstream of the dams is less turbid during floods, it remains turbid for longer periods of time than upstream, as the table below illustrates.

The dams have also collected silt and clay which carries iron and/or manganese on the particle surfaces and in the pore spaces between the particles. The iron and manganese particles are settling out due to their density, and are being concentrated in the silt and clay deposits in each reservoir lake bed where conditions are right to cause the particulates to partially dissolve.

Table 35. *Elwha River Turbidity Measurements Upstream and Downstream of the Dams (NTUs)*

DATE	UPSTREAM OF LAKE MILLS[a]	DOWNSTREAM OF BOTH DAMS[b]
02/01/95	570.0	125.0
02/02/95	200.0	148.0
02/03/95	75.0	136.0
02/04/95	15.0	119.0
02/05/95	10.0	82.9
02/06/95	7.0	68.7
02/07/95	7.0	50.9
02/08/95	7.0	68.7
02/09/85	6.3	39.3
02/10/95	6.5	39.7
02/11/95	4.8	34.4
02/12/95	3.6	33.6
02/13/95	2.4	28.2
02/14/95	2.6	26.4
02/15/95	2.1	28.0
02/16/95	1.6	22.5
02/17/95	12.6	19.7

[a] New USGS gauging station 12044900
[b] City of Port Angeles monitoring program

Normally, this material would wash out to sea in low concentrations, affecting neither human users nor aquatic life. Storage of the dissolved metals in lake beds sediments has therefore had a negligible to minor impact on water quality. However, because concentrations have built up in stored sediments, dam removal under the proposed action would require treatment facilities to rid the water of these fine particulates and associated dissolved metals.

Particulate organic matter also has been prevented from flowing downstream by the dams. Relatively large amounts of organic plant material fall into the river in the upper reaches, but the material settles in Lake Mills and Lake Aldwell. Also, the absence of salmonid fish carcasses supplying nitrogen and phosphorus has resulted in less of these nutrients than other Pacific Northwest streams. Low levels of organic matter generally limit aquatic invertebrate diversity and production in rivers below reservoirs (FERC 1993).

Table 36. *Water Quality Impact Indicators*

IMPACT INDICATOR	NO ACTION ALTERNATIVE
DO in % saturation	95-110
TSS (fines) in ppm	1-1,500
Turbidity (NTU)	1-800
Total Iron (µg/L)	20-2,300
Total Manganese (µg/L)	4-210
pH	6.7-10
Total Organic Carbon (mg/L)	0-10

SOURCE: USGS water quality data

The reservoirs have also affected downstream water temperatures, which are 2 to 4 degrees (Celsius) higher than normal during some parts of the late summer and early fall (FERC 1993). The increased temperature is a result of surface releases of reservoir water, which has warmed over the summer. Increases in disease and mortality in fish populations in the lower river have been correlated with and are major adverse impacts of these increased temperatures.

If the No Action alternative were selected, silt and clay-sized material with traces of iron and manganese would continue to build up behind the dams, and temperatures downstream would continue to be higher than under pre-dam conditions for several months of the year. Water quality downstream of the dams would continue to be less turbid than under pre-dam conditions, although withdrawals would likely increase as the population grows. Episodes of high turbidity during floods or upstream landslides would continue to occur periodically. Within several hundred years, the reservoirs would fill with sediment, resulting in a return to natural conditions including more turbid water and higher concentrations of iron and manganese downstream.

Some surface water users treat water now. Daishowa and Rayonier use settling channels, flocculants and/or filtering to prevent adverse impacts from turbidity. The Lower Elwha Klallam Tribal Fish Hatchery uses groundwater and a shallow infiltration gallery to help maintain a less turbid supply.

Conclusion

The reservoirs have moderately reduced turbidity, trapped iron and manganese particles, and increased temperatures downstream of the dams. This would continue if the No Action alternative were selected.

Impacts of the Proposed Action – River Erosion Alternative

Water Quality

The primary impacts to surface water would be the increase in concentrations of total suspended and dissolved solids, measured in milligrams per liter or parts per million, released from the reservoirs by the processes of erosion and transport downstream. The timing and rate of removal of the dams and the river discharge would have the greatest influence on downstream total suspended and total dissolved solids concentrations. Increases in both short- and long-term concentrations would result from implementing the proposed action, although short-term concentrations would be several orders of magnitude higher. In the long term (four to five years following the start of dam removal), while peak suspended sediment levels in the river could still occur occasionally at as much as seven times their current peak level, mitigation would ensure that surface water users continued to receive current water quality.

The primary impacts to surface water would be the increase in concentrations of total suspended and dissolved solids...

Turbidity levels would far exceed water quality requirements during dam removal and have major adverse impacts to water quality as well as users if proposed water quality mitigation measures were not integrated into project design. However, since protection of municipal and industrial supplies of water against adverse impacts of dam removal is required, measures to ensure standards are not exceeded for these users are built into both action alternatives. There would therefore be no impact to surface water industrial and municipal users from dam removal. In the long term, a moderate increase in turbidity would necessitate continued treatment of surface water supplies for some users. A summary of both short- and long-term protection measures is presented in the "mitigation" section.

Water quality might also be degraded by the release of dissolved iron or manganese from lake bed sediments. Analyses of reservoir bottom sediment samples, collected in March 1995, indicate that these metals are in the lake bed sediment pore water (i.e. spaces between sediment grains) in high concentrations. The actual concentration of dissolved iron and manganese in waters released during dam removal would be a function of the inflow volume, prevailing chemical conditions in the water, and the erosion rate, but a likely range for short-term concentrations is presented in table 37, for long-term in table 38. Short-term impacts from the release of iron or manganese are major adverse effects to water quality. In the long-term, these impacts would be minor.

A sufficient volume of these dissolved minerals may be released, short term, to aesthetically and/or physically affect downstream water users. Potential effects are bad tasting and tinted drinking water, iron and manganese staining, and precipitation plugging of water supply plumbing. Mitigation would reduce both suspended sediment and dissolved concentrations of iron and manganese to current levels, i.e. there would be no impact. Mitigation for groundwater users is described in Impacts to Groundwater.

The current and predicted measurements for the impact indicators of concern without mitigation measures are shown for each dam removal alternative in the following tables. Table 37 lists the short-term impacts to water quality for up to six years following dam removal with no mitigation. Table 38 lists the unmitigated long-term impacts that would result from the return of the natural upstream sediment supply.

The River Erosion alternative has the most potential for deviation from proposed schedule and anticipated total solids concentrations because of dependency on the natural river discharge, erosion, and transport rates. Proposed mitigation methods were selected for their qualities to adequately and efficiently mitigate for the projected short-term increases in suspended sediment, thereby meeting the requirements of the Elwha Restoration Act.

Numerous mitigation alternatives were evaluated. The adequacy determination for mitigation methods was based on project research, experience, engineering judgment, the results of lab tests which offered insight into the effectiveness of the chemical flocculants tested, the results of lake bed sediment analysis, and, to the extent possible, on local consensus.

Mitigation

Industrial Users and State Rearing Facility. Surface water for both the mills and the Washington State rearing facility is currently diverted from the river at a rock check dam into a tunnel south of the old Highway 112 bridge. Continued diversion of raw water using the current intake facility would require not only removing nearly all suspended sediment but larger bedload material as well. In addition, the rock dam would continue to impair some fish migration.

Table 37. *Short-term Water Quality Impact Indicators*
(up to 6 years following dam removal)

IMPACT INDICATOR	RIVER EROSION	NO ACTION
DO in % saturation	90-100%	95-110%
TSS (fines only) in ppm	28,000-51,000[a]	1-1,500
TSS in tons/day	500-350,000[a]	1.3-531
Turbidity in NTU	2,000-25,000[a]	1-800
Total Iron in μg/L	30,000-50,000[a]	20-2,300
Total Manganese in μg/L	500-10,000[a]	4-210
Maximum Daily Temperature in °C	15-19	19
pH	5-9	6.7-10
Total Organic Carbon in mg/L	100-1000	0-10

[a] Concentrations are expected to vary with removal activity and flow - these numbers represent maximum anticipated ranges of short duration (1-3 days) as lake bed sediments are eroded.

Table 38. *Long-term Water Quality Impact Indicators*
(beginning 2-6 years after dam removal, natural ambient conditions)

IMPACT INDICATOR	RIVER EROSION	NO ACTION
DO in % saturation	95-110%	95-110%
TSS (fines) in mg/L	69[a]	15[a]
TSS in tons/day	761.5[a]	51.3[a]
Turbidity in NTU	0.1-1,000	1-800
Total Iron in µg/L	10-5,000	20-2,300
Total Manganese in µg/L	10-700	4-210
Maximum Daily Temperature in °C	15-17	19
pH	6.8-8.5	6.7-10
Total Organic Carbon in mg/L	10-200	0-10

[a] Average values

For these reasons, the rock dam would be removed and an infiltration gallery buried under the riverbed in its place. The infiltration gallery would be composed of perforated pipes laid beneath the riverbed. These pipes would collect water filtered through the riverbed and direct it to the existing tunnel.

Mitigation options considered for the industrial water supply include an infiltration gallery with removal of the existing intake diversion, open channel treatment, temporary settling basins, provisions for three days of water storage, a permanent water treatment plant, a pipeline to bring clean water from above Lake Mills, and the construction of screens and fish passage measures on a replacement check dam. It is anticipated that the rearing facility would be closed and operations relocated during dam removal to protect fish in that facility. This could be a moderate short-term impact to chinook salmon production.

The proposed mitigation includes a combination of the infiltration gallery and open-channel industrial pre-treatment (see table 39).

The infiltration gallery would naturally reduce sediment load in intake water by filtration through the river alluvium. Each infiltration pipe would be surrounded by a graded sand and gravel filter that allows coarser particles to be filtered out of the inflowing water as it migrates toward the infiltration pipe. Hydraulic gradient, water velocities, and interstitial space would all increase moving from the riverbed to the pipe. Natural seasonal flooding and bed scouring would aid in removing filtered fine material from the upper portions of the riverbed.

Table 39. *Mitigation Measures Included — River Erosion Alternative (Proposed Action)*

SURFACE WATER USER	MITIGATION MEASURE
Industrial-Daishowa and Rayonier Mills	Infiltration gallery Open channel pre-treatment
Mills and State Rearing facility	Relocated (short-term) Infiltration gallery (long-term)
Lower Elwha Klallam Tribal Fish Hatchery	Add to infiltration gallery Two new wells for dilution Dredge existing outlet and create new bypass to Strait

The infiltration gallery would remain in place over the long term, to protect both industrial users and the state rearing channel when it reopens. Limited data gathered from the river water and the tribal infiltration gallery supply indicate suspended sediment concentration in water collected from the industrial infiltration gallery may be reduced by as much as 90% over the concentrations in surface water. The current suspended sediment concentration at the mills is approximately 8.4 parts per million (based on an 11-year average suspended sediment concentration at Daishowa Mill) after ambient conditions are restored. Based on current estimates of size and volume of fine material trapped in Lakes Mills and Aldwell (and assuming that infiltration galleries block particles larger than clay sizes), a long-term average of approximately 11 parts per million may be experienced at the infiltration gallery delivery to the pre-treatment open channel.

In addition to the infiltration gallery, open channel industrial pre-treatment would be required at a minimum for protection of industrial water supplies during removal. The open-channel treatment is designed to work in conjunction with the infiltration gallery. It consists of modifications to the existing upwell structure; installation of chemical/polymer feed tanks, rapid mixers, and instrumentation; and modifications to all or a portion of the 1900 feet of existing open channel between the upwell structure and the industrial pipeline inlet structure. The upwell structure would be expanded to allow for temporary bypass piping of flow requirements during construction of the pre-treatment system including modifications for instrumentation, chemical feed, and rapid mixers at the upwell structure. The open channel between the upwell structure and the pipeline inlet would be modified to create two separate, equivalent flow paths, each equal to the current capacity, to provide redundancy and maintenance shut-down capability.

The system would detect incoming turbidity and appropriately dose the influent with standard drinking water treatment flocculants, followed by a rapid mixing of chemicals and influent waters. As the mixture traveled toward the industrial pipeline inlet structure, the polymer would cause suspended sediment to flocculate and begin settling out under gravitational attraction. In addition, lamella plates or tube settlers would be installed to improve suspended sediment reduction efficiency by reducing turbulence and providing agglomeration sites that promote gravity settling, reducing required retention time and space requirements. A collection system would aggregate the settled solids which would be pumped back to the river for discharge below the city of Port Angeles Ranney well. As high turbidity would correlate to high flow conditions, the system would be removing the most sediment at the highest river flows, and the return of settled solids would not induce a measurable increase in downstream turbidity. Due to the anticipated total suspended solids concentrations and the required industrial pre-treatment efficiency, the sheer volume of solids produced would preclude separation and removal to a landfill site.

The system would be installed and operational prior to the start of dam removal, would operate continuously during the dam removal and lake bed sediment erosion period, and be monitored and controlled through telemetry. It would operate intermittently as the river returned to a natural state to remove the effects of natural increases in total suspended solids concentration during higher flow periods. The effectiveness of pre-treatment and the infiltration gallery on industrial water is summarized in table 40 below.

The industrial pre-treatment system could function as a source for emergency water supply for Port Angeles, with modifications to the proposed city temporary treatment package plant, although there is no current indication that this would be necessary.

Lower Elwha Klallam Tribal Fish Hatchery. The tribal fish hatchery would be central in protecting and producing Elwha anadromous fish for restoration. Plans for expanding the hatchery are described in the Alternatives chapter.

Water yield to the hatchery would need to be increased and water quality protected during dam removal. Currently, water is collected through a shallow infiltration gallery located beneath the Elwha River upstream of the hatchery.

Table 40. *Water Quality Before and Following Proposed Mitigation*
(critical impact indicators, industrial diversion water)

IMPACT INDICATOR	DURING CONSTRUCTION (IN RIVER WATER)	LONG-TERM (IN RIVER WATER)	W/MITIGATION (AFTER TREATMENT)
Turbidity (NTU)	2,000-25,000	1-1,000	1-800
Total Iron (µg/L)	30,000-50,000	10-5,000	20-2,300
Total Manganese (µg/L)	500-10,000	10-700	4-210
pH (SU)	5-9	6.5-8.5	6.5-8.5

This part of the river would be expected to aggrade, and the increased alluvium covering the hatchery gallery could reduce capacity. Also, the river could meander away from the gallery and decrease yield. To ensure sustained capacity, the tribal hatchery infiltration gallery would be increased in length. The additional infiltration pipe would be installed adjacent to and just downstream of the existing structure (on tribal land on the left bank of the Elwha River) at approximately river mile 1.0.

Treatment of water from the infiltration gallery would be required for the highest anticipated suspended sediment concentrations during dam removal. Measurement and estimates of sediment in water collected from the infiltration gallery indicates that concentrations may be 10–25% of suspended sediment concentrations in the river column. Treatment methods investigated include filtration and flocculation or dilution. Dilution was considered preferable to filtration and flocculation due to costs and the potential for effects on fish. Dilution would be accomplished by mixing well water with river water. Two wells would be constructed on tribal lands to supply dilution water (see Impacts to Groundwater). For short periods when river sediment concentrations are too high to use surface water, a well water aeration device would allow recirculation and re-aeration to help reduce the amounts needed from the wells.

Aggradation and an increased surface water elevation near the tribal hatchery outflow could also impact hatchery operation. Under normal operations, outflow from the hatchery exits via Bosco Creek, which is expected to aggrade during and following dam removal. Periodic dredging would be required to keep this outlet open. During high flows, an outlet pipe flowing under the flood protection levee adjacent to the hatchery bypasses Bosco Creek. Increased surface elevations could cause backflow from this bypass into the hatchery. A new outlet discharging into the Strait of Juan de Fuca would alleviate the problem.

Water Quality Monitoring. A monitoring plan administered by the US Geological Survey for sediment management would include sampling for critical and basic water quality parameters. Sampling sites include the new station above Lake Mills (to be relocated to Goblin Gates), the historic McDonald's bridge station gauge, and a new site to be established just below Elwha Dam. Sampling parameters and frequency would be determined by regulatory requirements and dam removal activities to ensure adequate data coverage of the pre- to post-dam removal water quality impacts.

The established historic baseline from McDonald bridge station would be used for comparison during the deconstruction period. After the dams were removed, data from the new upper station (at Goblin Gates) would be compared with data from the new lower station below the former Elwha dam site to determine conclusion of dam removal impacts to water quality and reestablishment of natural conditions.

Cumulative Impacts

There is potential for cumulative impacts from suspended sediments from river erosion due to natural landslide events upstream of Lake Mills or forest fires within the watershed. This could temporarily increase suspended sediment load in addition to the effects of dam removal, and overload mitigation measures on a short-term, infrequent basis.

Conclusion

Dam removal would result in one to two year large increases of turbidity, suspended sediment and possibly of manganese and iron. All would have major adverse impacts on downstream water quality. Minor changes to pH, temperature and dissolved oxygen would also occur during dam removal. Beginning two and six years after dam removal, turbidity, suspended sediment and dissolved iron and manganese would settle to levels slightly to moderately higher than under conditions now. Increased suspended sediment and turbidity would have a long-term moderate adverse impact on water quality; increased iron and manganese would have a long-term minor impact. Temperatures would be decreased in late summer and fall as a result of dam removal. This would be a major beneficial impact to water quality and aquatic life. Changes in pH and dissolved oxygen would have negligible or minor impacts to water quality.

Surface water users would, for the most part, not be affected in either the short or long term by dam removal, as mitigation to protect them against adverse impacts of dam removal is required. The exception may be the Washington Department of Fish and Wildlife rearing facility, which would be relocated in the short term during dam removal (for up to five years). This may moderately adversely affect its operations.

Surface water users would, for the most part, not be affected in either the short or long term by dam removal...

Water quality monitoring during and following removal would help identify and mitigate any additional unknown or unanticipated impacts.

Impacts of the Dredge and Slurry Alternative

Under the Dredge and Slurry alternative, about 4.3 million cubic yards of fine-grained lake bed sediment would be dredged from both reservoirs and transported to the strait through a slurry pipeline. Material trapped in the deltas of both lakes, approximately 2.4 million cubic yards of fine-grained sediment, would not be accessible to dredges; a portion of it would erode downstream with the coarser grained materials. Erosion of the fines that are mixed with the coarser grained deposits in the deltas would increase suspended sediment concentrations downstream when coarse material eroded during and following dam removal.

Dredging techniques would not be able to remove 100% of the erodable lake bed sediments. Physical limitations of the dredging equipment, especially in areas of the lake beds left with logs and tree stumps prior to impoundment, would leave some fine sediment. Tree stumps and logs would limit dredging access to material below the wood debris. Remaining fine sediment would be covered by the eroding delta sediment, later to erode and wash downstream. It is estimated that 75% of the lake bed sediment could be dredged, leaving 1.2 to 1.4 million cubic yards of fine material to enter the water column. The magnitude of impacts would be much less than that under the River Erosion Alternative, but the durations of increased turbidity would be about the same (see table 41).

The impacts due to suspended solids would be significantly less on average with the Dredge and Slurry alternative, in the range of 3,000–5,000 parts per million compared to 6,700 to 51,000 parts per million for the River Erosion alternative (the proposed action). The peak periods would remain the same; however, the magnitude of the peaks would decrease if fines were dredged before the dams removed. Since the possibility of an extreme peak exists for both alternatives, the type of mitigation required for surface water users is the same in both alternatives.

Mitigation

Industrial Users and State Rearing Channel. Like the River Erosion alternative, an infiltration gallery and pre-industrial treatment are an integral part of the Dredge and Slurry alternative to protect the two mills now using Elwha River water. The infiltration gallery would stay in place over the long term, and would help reduce turbidity levels for the mills and for the Washington State rearing facility, which is expected to reopen following dam removal. Because turbidity would be less than under the proposed action, the rearing facility may be able to re-open sooner under this alternative.

The dredging operation is expected to remove approximately 75% of the fine material behind the dams; therefore, the operation and maintenance costs for the treatment of industrial water would average less than if the River Erosion alternative were implemented. For instance, the pre-industrial treatment involves the use of a polymer to flocculate sediment from water collected from the infiltration gallery. Less of this polymer would be required under the Dredge and Slurry alternative. Impacts are expected to be shorter duration as well, lasting only one to two years.

Lower Elwha Klallam Tribal Fish Hatchery. Mitigation would be the same as in the proposed action.

Water Quality Monitoring. The same water quality monitoring program described in Impacts of the proposed action would be used if the Dredge and Slurry option were selected. Since less sediment is eroded, there is a potential cost savings as it would take less time to return to natural conditions, requiring fewer samples and analyses.

Conclusion

Impacts to water quality would be less severe under the Dredge and Slurry alternative. A large portion of the most problematic portion of the total sediment load, i.e., fine-grained sediment, would be removed from the need for treatment, reducing operation and maintenance costs. The duration and uncertainty of the impact and the need for long-term monitoring also would be reduced. Impacts to users would be nearly identical to the proposed action, except costs of operation and maintenance of the treatment facilities would be lower. The Washington Department of Fish and Wildlife rearing facility may be able to re-open sooner under this alternative.

Table 41. *Surface Water Suspended Sediment Concentrations for Sequential Steps in Dam Removal Comparing River Erosion and Dredge and Slurry Alternatives*

SOURCE OF IMPACT	DAYS LESS THAN 200 PPM	DAYS AT 200-1,000 PPM	DAYS AT 1,000-10,000 PPM	DAYS AT GREATER THAN 10,000 PPM
Begin lake drawdown for dam removal (River Erosion)	31-43	11-81	52-170	0-26
Begin dam removal and lake drawdown (Dredge and Slurry)	41-81	43-122	7-76	0-1
Stop during winter floods (River Erosion)	20-85	0	0	0
Stop during winter floods (Dredge and Slurry)	20-119	0	0	0
Continue after winter floods (River Erosion)	0-3	0-43	20-83	0-2
Continue after winter floods (Dredge and Slurry)	0-36	8-63	12-38	0
Stop for high spring runoff (River Erosion)	80-100	0	0	0
Stop for high spring runoff (Dredge and Slurry)	96-100	0	0	0
Complete dam removal (River Erosion)	0	1-21	62-105	3-25
Complete dam removal (Dredge and Slurry)	1-6	27-84	22-61	0-1
Erosion after dam removal (River Erosion)	606-698	1-24	2-76	2-6
Erosion after dam removal (Dredge and Slurry)	625-708	1-71	4-13	0

SOURCE: Bureau of Reclamation (BOR) 1995f

Table 42. *Water Quality Before and Following Proposed Mitigation — Dredge and Slurry Alternative*
(critical impact indicators, industrial diversion water)

IMPACT INDICATOR	DURING CONSTRUCTION (in river water)	LONG-TERM (In river water)	W/MITIGATION (after treatment)
Turbidity (NTUs)	1,000-10,000	1-1,000	1-800
Total Iron (g/l)	5,000-15,000	10-5,000	20-2,300
Total Manganese (g/l)	50-1,500	10-700	4-210
pH	6-9.5	6.5- 8.5	6.5-8.5

Groundwater

Summary of Regulations and Policies

The Safe Drinking Water Act provides requirements and standards for public drinking water supplies.

The Washington Department of Ecology and Department of Health Drinking Water regulations apply to existing water supplies.

The Elwha Restoration Act, Public Law 102-495, requires protection of existing quality and availability of water from the Elwha River for municipal and industrial uses.

Methodologies for Analyzing Impacts

A study of the hydrogeology of the Elwha River watershed identified the area of potential impact as being restricted to the alluvial river valley. All available well logs were reviewed for location, well completion details, and well head elevations. The elevations were compared to the projected post-dam 100-year-flood level to determine whether they would be subject to increased flooding hazards.

Several of the wells in the lower river valley, on the Lower Elwha Klallam Reservation, were monitored monthly (and one monitored continuously) for one year to evaluate the river's influence on groundwater levels and to determine the groundwater gradient. Estimated changes in groundwater levels, after dam removal, were based on projected levels of riverbed aggradation and present river stage/groundwater level relationships. Current and predicted water quality parameters were compared for those purveyors with sample analyses.

Impacts of No Action

Turbidity

The Elwha River reservoirs act as large settling basins, removing all of the coarse sediment and some of the fine sediment that is transported from upstream. Therefore, water is on average slightly less turbid downstream than above the dams. In high flow events, water downstream of the dams, where all groundwater users are located, is less turbid than upstream, but remains turbid for longer periods of time. Wells that are hydraulically connected to the river (Dry Creek Water Association, Elwha Place Homeowners' Association, and some individual wells) may have less turbid supplies with the dams in place because of this phenomenon.

Turbidity of the Port Angeles Ranney well water is lower than in the river because alluvial sands and gravels filter out a large portion of the particulate matter. The 1994 measured mean turbidity of 0.08 NTU (nephelometric turbidity units — a measure of how intensely light is scattered by particles in the water) does not exceed drinking water standards of 1.0 NTU. The maximum turbidity detected in the city's well from 1983 to 1993 was 4.8 NTU.

Yield

The armoring of the riverbed with coarse cobbles and gravel and the removal of sand and fines have contributed to increased hydraulic connection between the river and the underlying aquifer. The Port Angeles Ranney Collector, and other high yield wells, depend on the induced recharge from the river to maintain high yields.

Manganese/Iron

Iron was detected above maximum contaminant levels two times in the Port Angeles Ranney well samples taken from 1983 to 1993. Although the mean iron concentration of 0.2 milligrams per liter was below state drinking water standards of 0.3, the maximum concentration detected was 1.0 milligram per liter. Samples of fine lakebottom sediment from Lake Mills were tested and found to contain high pore water concentrations of iron (average of three samples was 27.5 milligrams per liter) and manganese (average of three samples was 4.67 milligrams per liter).

Lake Aldwell.
(Curtis Miller photo)

Water Table Levels

Lake Aldwell supports an artificial constant head (groundwater surface elevation) at the east end of Indian Creek valley, near the confluence of Indian Creek and the Elwha River. At least two wells in this area are able to access groundwater at a shallower depth because of this. Also, some residents at the north end of the Lower Elwha Klallam Reservation have been able to install septic systems because groundwater levels are lower than under pre-dam conditions. This is due to the riverbed degrading (see Fluvial Processes) without continued supply of sand and gravel, and a consequent dropping of river's surface elevation.

Meander and Flooding

The dams have resulted in less frequent meander, flooding, and erosion. Consequently, wells are built to survive an artificially low flood elevation. With the decreased sediment supply, the channel migrates less frequently and over a narrower section of the floodplain. This has helped to stabilize some of the riverbanks, and wells have been built very near the river's edge. Despite the reduction in meander frequency, the river has moved far enough away from the Port Angeles Ranney collector that yields have been affected.

Conclusion

The dams have affected groundwater users by decreasing turbidity during peak flows, holding back manganese and iron that would normally flush through the system, and increasing groundwater tables for some well users and artificially decreasing it for lower Elwha valley users. Meander and flooding frequency have been reduced through the elimination of sediment transport to the middle and lower reaches, resulting in the armoring of the downstream riverbed. This has increased yield for some wells, and allowed well users to drill wells in the floodplain.

Impacts of the Proposed Action – River Erosion Alternative

The extent of the impact to water quality degradation would depend on the method and timing of sediment releases during dam removal. Fine sediments from the turbid river may infiltrate the well screens of near-river wells and the coarse riverbed substrate, potentially decreasing hydraulic continuity between the river and aquifer. The increased bedload of the river would promote renewed channel migration and bank erosion which may also impact near-river wells. As the riverbed aggraded, the river stage and future flood levels would be higher as well. Wellhead elevations of several wells in the floodplain are below the current 100-year flood level. Mitigation for each set of impacts is discussed in each section below and summarized in table 43.

Impacts from Increased Turbidity

Port Angeles Ranney Collector and Dry Creek Water Association Wells. The primary impact to wells from the proposed action in both the long- and short-term would be from increases in turbidity, and from aggradation of the riverbed in the long term. Some of the fine sediment might settle out in the interstices (spaces between granules) of the coarse riverbed material and decrease the rate of infiltration from the river to the alluvial aquifer. A decrease in yield, particularly from the Port Angeles Ranney collector, could result.

The riverbed has been sufficient, under present river conditions, to remove most of the fine sediment from water entering the Ranney Collector laterals. Infrequently though, collector water samples have exceeded the 1.0 NTU maximum contaminant level, and additional fines in the water during dam removal may increase fines in the water supplies.

The Dry Creek Water Association wells are often affected during periods of high river turbidity. Projected levels of suspended sediment with the river erosion alternative could exceed 50,000 parts per million for short periods during dam removal; this would likely cause water in these wells to exceed the regulated turbidity levels.

Lower Elwha Klallam Tribal Fish Hatchery. The Lower Elwha Klallam Tribe presently operates a fish hatchery fed in part from water flowing into an infiltration gallery placed in the lower Elwha River. An increase in suspended sediments in the river along with aggradation of the riverbed over the hatchery infiltration gallery would probably decrease the capacity of the gallery and increase the turbidity of water delivered. These impacts are further discussed in the section on surface water.

Other Users. Elwha Place Homeowners' Association and other individual well users may also be affected by turbidity (see table 43). Most of these wells are likely to experience only slight increases in turbidity during dam removal, and even unmitigated impacts are likely to be minor.

Impacts from Increased Mobilization of Iron or Manganese

Port Angeles and Dry Creek Water Association. Samples of fine lakebottom sediment from Lake Mills were tested and found to contain high pore water concentrations of iron (average of three samples was 27.5 milligrams per liter) and manganese (average of three samples was 4.67 milligrams per liter). The dissolved iron and manganese concentrations could remain elevated with additional leaching from the sediment during transport and deposition, and cause iron fouling of water delivery systems and mineral staining of fixtures and clothing. Because this form of iron and manganese is dissolved, it would move with the groundwater into the aquifer. Iron may also oxidize and precipitate out of solution. This particulate iron (ferric hydroxide) would be transported with the majority of the sediment to the strait. Although the potential to infiltrate aquifers exists, the EIS team believes a major impact to well users from increases in manganese or iron is highly unlikely and that most well users would only experience minor impacts.

Impacts From Changes of Water Table Levels

Middle Reach and Lower Elwha Valley Users. Lake Aldwell supports an artificial constant head (groundwater surface elevation) at the east end of Indian Creek valley, near the confluence of Indian Creek and the Elwha River. If Elwha Dam is removed and Lake Aldwell drained, the gradient of the groundwater surface in the valley aquifer would steepen and wells within this area might have lower water levels. At least two wells in this area could be affected and perhaps need to be replaced. The new wells would be drilled deeper than the existing wells or would be relocated to sites where sufficient water could be obtained. This would be a major impact to these users.

Table 43. *Groundwater Impacts and Mitigation*

GENERAL LOCATION[a]	POSSIBLE IMPACTS	PROPOSED MITIGATION
Upstream of Hwy. 101 Bridge	Increased flood potential (overtopping of wellhead)	Raise and modify wellhead
	Water quality degradation due to increased river turbidity	Temporary in-line sediment filter and bottled water as a backup
	Water quality degradation due to iron and/or manganese	Temporary storage tank and delivery of water to residence
Upstream of Lake Aldwell, Indian Creek Valley	Decreased piezometric level	Drill well or deepen existing well
	Increased flood potential	Connect to new Ranney Collector
Dry Creek Water Association	Water quality degradation due to increased river turbidity	Connect to new Ranney Collector
	Water quality degradation due to iron and/or manganese	Water treatment system (Port Angeles)
City of Port Angeles	Possible decreased yield from existing Ranney Collector	Construct second Ranney Collector to provide supplemental flow
	Water quality degradation due to iron and/or manganese	Water treatment system
Lower River Valley Wells Including State Rearing Channel Wells	Increased flood potential	Raise and modify wellhead
	Water quality degradation due to increased river turbidity	Temporary in-line sediment filter and bottled water as a backup
	Water quality degradation due to iron and/or manganese	Temporary storage tank and delivery of water to residence
Elwha Place Homeowners' Association	Increased flood potential	Modify wellheads and flood-proof pump house
	Water quality degradation due to increased river turbidity and/or iron and manganese	Temporary water treatment system
Lower Elwha Klallam Tribe	Increased groundwater levels	Modify about 10 conventional septic systems to mound systems with lift stations
Unidentified Water Users	Unanticipated impacts	Monitor groundwater quality
		Contingency fund for mitigation

[a] Not all wells within a given general location would have the same impact and mitigation. Individual well construction features and specific location would determine impact and mitigation at each specific site.

Increases in river elevation of 1 to 4 feet over the next 50 years would be expected in the lower river valley due to redistribution and deposition of sediment presently trapped in the reservoirs. A higher river stage would also cause an increase in water table elevation and affect septic systems along the lower reach. All homes in the lower delta area utilize on-site sewage disposal systems; at some, the water table is presently less than 5 feet below ground surface. Consequently, during seasonal high water levels and high tidal conditions, the conventional septic systems are probably in contact with the water table, despite Clallam County requirements of a minimum of 3 feet separation between the septic system drain line and the water table. The water level elevation varies with river stage at approximately a 0.3:1 ratio, or a 1-foot rise in river stage causes an approximate 0.3-foot rise in water table at the Bosco well, located 1,500 feet from the river. A water table rise of approximately 1 to 3 feet would eventually be expected in the lower delta area during floods and would aggravate the septic system problem. This is considered a moderate impact to users which would occur only in the long term.

Impacts from Increased Flood Potential

Elwha Place Homeowners' Association and Wells in the Floodplain. In select spots throughout the river valley, the potential for flooding would increase with riverbed aggradation and bank erosion due to increased river meander. Several near-river wells could be affected through overtopping during high flow events. When a wellhead is overtopped, raw, unfiltered river water flows down from the top and contaminates the groundwater in the well. This is considered a major impact. The Elwha Place Homeowners' Association wells, located in the floodplain at river mile 1.4, may experience these problems.

Some of the domestic wells located south of Highway 101, along Olympic Hot Springs Road, may be subject to degraded water quality due to their close proximity to the river, their shallow depths, and their low elevations relative to possible flood levels. The responses in a water use inventory stated that the water from these wells does not get cloudy during periods of high river turbidity. Since the concentration of suspended solids is projected to increase, it is possible that some of these wells would begin to show a correlation between river and well water turbidity during dam removal.

Mitigation

The Elwha Restoration Act specifically requires the protection of Port Angeles and Dry Creek Water Association from adverse impacts of dam removal. Also, the Lower Elwha Klallam Tribal Fish Hatchery is required to be operational during dam removal to facilitate fish restoration. Therefore, mitigation for these users is mandatory and built into both action alternatives. Other mitigation described below and in chart form in table 43 is recommended and would be committed to in the record of decision on this project (completed after this environmental impact statement is finalized) by the secretary of the interior or designee.

Port Angeles/Dry Creek Water Association. To jointly mitigate possible decreased capacity from the Port Angeles municipal system and to provide a less turbid source for the Dry Creek Water Association, an additional Ranney collector is proposed. It would be located on the west bank of the river, slightly upstream of the present Ranney collector, so that changes in river position would not simultaneously impact the capacity of both collectors. Installation of the new collector would ensure that quality of the Port Angeles municipal supply and that of Dry Creek Water Association users remains as high as at present.

If the Dry Creek Water Association did not join the Port Angeles system, mitigation for impacts to their system would include abandoning the two shallowest wells (numbers 1 and 2), drilling a new well (farther from the river edge), equipping both the new well and well number 4 with pumps and ancillary equipment, and building a new chlorine station and filtration treatment system. Severe limitations to land easements and physical space for the new well and treatment systems make this option less attractive than connecting the association to the new Ranney Collector. Cost estimates in this DEIS are based on Dry Creek Water Association connecting to the Port Angeles system.

The temporary water treatment systems proposed as mitigation for Port Angeles, Dry Creek Water Association, and Elwha Place Homeowners' Association would eliminate the iron/ manganese impacts to the water supplies. Additionally, the treatment plants would double as temporary filtration systems for high suspended sediment concentrations during dam removal.

Lower Elwha Klallam Reservation Residents. Mitigation plans include replacing the conventional waste disposal system with a mounded system and lift station at approximately 10 households in the affected area. Such a plan would meet county standards and maintain or improve septic system conditions for these homeowners.

Elwha Place Homeowners' Association and Wells in the Floodplain. At least ten private domestic wells, one well at Elwha Campground, and three wells at the state rearing channel would need to raised or modified to be protected from water quality degradation due to overtopping of the wellheads. In addition to extending the well casing above flood levels, appropriate changes to the discharge piping and electrical systems would be needed.

The Elwha Place Homeowners' Association wells, located in the floodplain at river mile 1.4 would require wellhead modifications and flood-proofing of the well pumphouse to ensure protection. Since the homeowners' association water supply does not become turbid when the river does, no water treatment is currently required. If the river begins to meander more frequently, it could eventually move closer to the wells, affecting their quality or stability. Because of the proximity of the wells to the river, temporary in-line treatment for sediment and iron filtration has been proposed to mitigate for the potential of high levels of iron releasing from eroded lake bed sediments.

In order to mitigate for impacts to domestic well users located south of Highway 101 along Olympic Hot Springs Road, a point-of-entry sediment filter and a temporary source of bottled drinking water to approximately ten households are proposed.

Lower Elwha Klallam Tribal Fish Hatchery. Water treatment for the hatchery would be required at times of highest suspended sediment concentrations during dam removal. Since treatment methods using flocculation may not be possible due to the unknown effects on fish, treatment by dilution with groundwater has been proposed. Presently, the hatchery uses approximately 6,000 gallons per minute; two-thirds of this amount is supplied by surface water from the infiltration gallery and the other third by groundwater from two production wells. To dilute to the extent needed, about 5,800 gallons per minute would be required. Based on earlier studies, the wells must be carefully located to prevent saltwater intrusion into the aquifer if pumping at this rate continues for a long period of time (more than 60 days). Drilling them near the river would induce flow from the river to the wells and prevent saltwater intrusion. An 8-inch test well and one or two small diameter observation wells would be drilled initially on the floodplain to determine the ratio of water contributed by the river, and any impacts on nearby wells before final location for the hatchery wells was decided.

Unanticipated Impacts

A well and water use inventory conducted during the summer of 1994 identified one Elwha River water user who did not draw water from a well but filled containers from the river for home use. Since the inventory had an approximate 40% response rate, other water users may as yet be unidentified; these users could be affected by the increased turbidity and degradation of water quality during dam removal processes, depending on well location. In addition, several respondents noted that they were planning to drill a well within a year or two. A contingency fund has been proposed to finance unforseen mitigation measures which may include raising and modifying wells.

Cumulative Impacts

Dam removal will cause the short-term degradation of water quality in the alluvial acquifer. Over the long term it will raise groundwater levels as a result of channel aggradation. Additional wells for the Lower Elwha Klallam Tribal Fish Hatchery and infiltration galleries for the mills, rearing channel and hatchery would increase demands on groundwater.

Conclusion

Groundwater users could be affected by infiltration of fine sediments into riverbed substrate or through well screens which would increase turbidity and/or decrease yield from the aquifer. Increased bedload of the river would promote renewed channel migration and bank erosion, which may affect yield. Riverbed aggradation would increase river stage, and wells may be overtopped and contaminated. Mitigation for Port Angeles, Dry Creek Water Association, and the Lower Elwha Klallam Tribal Fish Hatchery is mandatory and would effectively eliminate impacts of dam removal to these users. Recommended mitigation for other users, including the Elwha Place Homeowners' Association, Lower Elwha Klallam Reservation residents, and individual well users would also reduce impacts to minor levels. Without mitigation, these users would experience minor to major impacts from dam removal.

Impacts of the Dredge and Slurry Alternative

Impacts from Increased Turbidity

The Dredge and Slurry alternative reduces the magnitude and duration of fine sediment impacts to the Elwha River surface water. The turbidity of the river would, however, be greater than under present river conditions and would still require mitigation to meet the requirements of the Elwha River Restoration Act. The Dry Creek Water Association wells show increases in turbidity during high flows and would exceed the state maximum contaminant level of 1.0 NTU during dam removal. Other near-river wells also may experience higher than current suspended sediment loads.

Mitigation for Port Angeles, Dry Creek Water Association, and the Lower Elwha Klallam Tribal Fish Hatchery is mandatory and would effectively eliminate impacts of dam removal to these users.

Impacts from Increased Mobilization of Iron and Manganese

Since a majority of the fine sediment stored behind the dams would be slurried to the strait and not enter the river system, the impacts from released iron and manganese would be greatly reduced. The proposed temporary treatment system for the Elwha Place Homeowners' Association would likely not be needed. The treatment system for the proposed new Ranney Collector would still be recommended due to the unproven effectiveness of sediment filtering by the new collecting laterals under the riverbank.

Impacts from Changes of Water Table Levels

Changes in groundwater levels would be the same under this alternative as under the proposed alternative. All of the mitigation plans in the proposed alternative section would still apply.

Impacts from Increased Flood Potential and Unanticipated Impacts

As with changes in groundwater levels, the flood potential impacts would be the same under this alternative. All mitigation plans listed in the proposed alternative section would apply.

Conclusion

The duration and amount of short-term mitigations for some local wells would be reduced. The temporary treatment plant for the Elwha Place Homeowners' Association would probably not be needed due to the reduction of fine sediment and iron/manganese carried by the river or entering the aquifer. Mitigation for the protection of Port Angeles, Dry Creek Water Association, and the Lower Elwha Klallam Tribal Fish Hatchery is considered mandatory and included as part of the Dredge and Slurry alternative. Other mitigation described in the proposed action and in this section are recommended for adoption. Minor to major impacts are expected to users without mitigation, and minor or no impact with mitigation.

Native Anadromous and Resident Fisheries

Summary of Regulations and Policies

The following from *National Park Service Management Policies* (1988a) provide direction for management of fisheries on park lands.

"Fisheries management will seek to preserve or restore natural aquatic habitats and the natural abundance and distribution of native aquatic species, including fish, together with the associated terrestrial habitats and species."(4:8)

"Artificial stocking of native fish will be employed in natural zones only to reestablish native species in their historic ranges." (4:8)

"Parks having native migratory species [including salmon] will ensure the preservation of their populations and their habitats inside the park and will cooperate wherever possible with others to ensure the preservation of their populations and habitats outside the park." (4:7)

Coho salmon leaping at Salmon Cascades, Olympic National Park. (Janis Burger photo)

"The NPS will strive to protect the full range of genetic types (genotypes) native to plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity. The introduction of native plants and animals will be accomplished using organisms taken from populations as closely related genetically and ecologically as possible to the park populations" . . . (4:10)

"The NPS will strive to restore native species to parks wherever.... the following criteria can be met: Adequate habitat to support the species either exists or can reasonably be restored.... The [restored population] most nearly approximates the extirpated subspecies or race.... the species disappeared, or was substantially diminished, as a direct or indirect result of human-induced change to the species or to the ecosystem." (4:10)

Other state, federal, and tribal agencies also establish fisheries management policies and regulations affecting the Elwha River. For the Strait of Juan de Fuca fisheries, including the Elwha River, policies and regulations are established through the cooperative efforts of the Washington Department of Fish and Wildlife and various tribes, including the Lower Elwha Klallam Tribe, Jamestown S'Klallam, Port Gamble S'Klallam, and Makah tribes. The Elwha Tribe administers tribal freshwater fisheries in an area from the Hoko River to Morse Creek, including the Elwha River.

The Pacific Fisheries Management Council is responsible for the management of all US salmon fisheries in the Conservation Management Zone along the coastal marine waters of Washington, Oregon, and California that potentially impact Strait of Juan de Fuca stocks. Each year, management guidelines are adopted by the Pacific Fisheries Management Council based on projected run sizes and fishery objectives.

Other state and federal regulations affecting fisheries include: The State Hydraulic Code (Chapter 75.20.100-140 RCW) intended to protect fish life from damage by construction and other activities in all waters of the state; it is carried out through a permit, the hydraulic project approval, obtained from the Washington Department of Fish and Wildlife; The Fish and Wildlife Coordination Act requires that equal consideration be given to wildlife, including fish, when proposing to control or modify any stream or other water; and section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act require US Army Corps of Engineers permits for construction and disposal of dredged material in waters of the United States.

Methodologies for Analyzing Impacts

In the Department of the Interior's programmatic environmental impact statement on the restoration of the Elwha River ecosystem, the restoration potential for each run of salmon was assessed using four factors: available stock; ability for adults to pass over dams as they migrate upstream and juveniles to pass downstream on their way to sea; the condition of the stream habitat; and fishing pressure. Quantity of habitat restored or accessible to native stocks was measured in river miles. New native fish production under each alternative was estimated using the Ricker spawner/recruit model modified from the FERC *Draft Staff Report* (FERC 1993). These results are summarized in this environmental impact statement so that readers do not need to refer back to the programmatic EIS.

Tagging coho salmon carcasses for a study on the fate of carcasses in Olympic Peninsula streams. (Janis Burger photo)

The focus of this environmental impact statement, however, is the sensitivities of native salmonid species to temporary (short-term) habitat degradation caused by dam removal and release of sediments, and the effectiveness of the fish restoration plan (appendix 2), including hatchery support and outplanting. The primary short-term impact to fisheries in the Elwha River expected from dam removal is an increase in sedimentation and turbidity. The amount and rate of reservoir sediments released downstream would vary by sediment management alternative. To assess these impacts, the EIS team used a sediment model to estimate sediment rates for a wide range of hydrologic conditions (BOR 1995f). Conditions were simulated using historic flows for four different three-year periods. The model accounted for periods when lake drawdown would be stopped due to high flows or to protect fish.

Suspended sediment concentrations and duration were then compared with salmonid thresholds. Three suspended sediment concentration thresholds were selected for purposes of this analysis: at levels that 1) cause physiological stress, reduced growth, and avoidance (200 parts per million), 2) are lethal from chronic exposure (1,000 parts per million), and 3) are lethal from acute exposure (10,000 parts per million) (milligrams per liter and parts per million are nearly equivalent for concentrations up to 10,000 parts per million). Using simulation results, the number of days, time of year, and species most likely affected when these thresholds would be exceeded were determined (see discussion below).

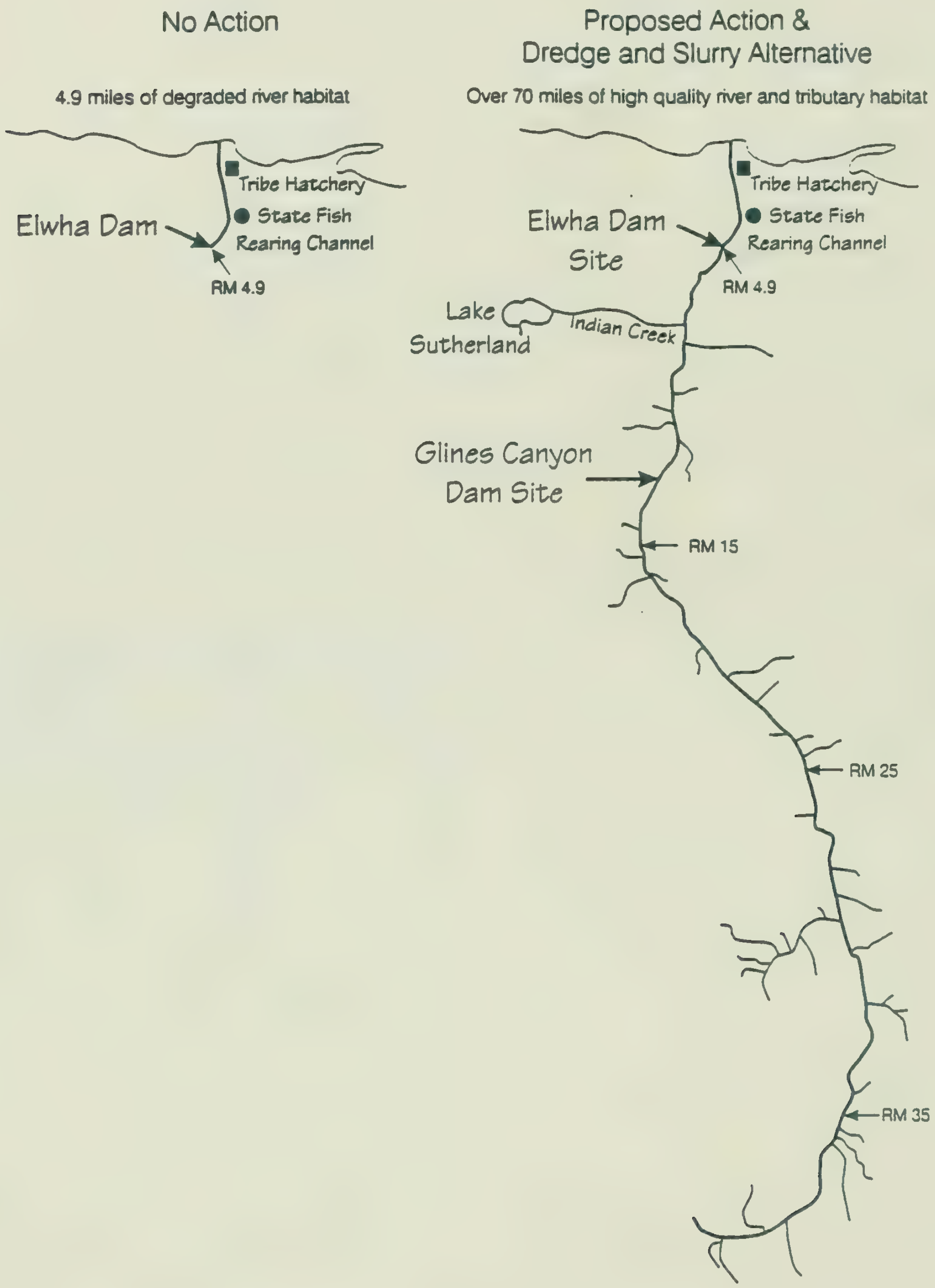
Impacts of No Action

Building the dams had an immediate and devastating impact on the 10 runs of Elwha anadromous fish. The river went from producing more than 380,000 salmon and seagoing trout in 1910 (based on habitat available to the fish and standard fish production modeling) to fewer than 3,000 wild native anadromous fish today. Hatcheries now provide the vast majority of salmon and steelhead in the river, and existing stocks in the lower river unsupported by artificial propagation would decline to extinction if the No Action alternative were selected.

Approximately 70 miles of the mainstem river and its tributaries are estimated to have been available to anadromous species before the dams were built. All but the lowest 4.9 miles, or 93%, of this habitat was eliminated when Elwha Dam was built in 1910 (see figure 22). Steelhead and possibly other species could have traveled as far as 43 miles up the 45-mile mainstem channel before encountering impassible stretches (James River II 1988). Carlson Canyon Falls at river mile 34 may have blocked some species, depending on timing and condition of the fish. It is unknown but widely speculated that the relatively poor jumping ability of pink and chum salmon may have restricted them to the region below Rica Canyon (river mile 16) (James River II 1988).

The current quality and quantity of potential habitat are degraded in the middle reach (James River II 1988) because the Glines Canyon Dam has held back the gravels fish require for spawning (WDF 1971). In addition, the 2.8 miles of mainstem river currently inundated by Lake Aldwell are wholly unavailable for spawning. The channel is also less meandering with little of the pool and side channel habitat fish need to successfully rear (see Impacts of No Action on fluvial processes and sediment transport).

Figure 22. Comparison of Elwha River Anadromous Fish Habitat under Each Alternative
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20079


No Action
4.9 miles of degraded river habitat
Tribe Hatchery
State Fish Rearing Channel
Elwha Dam
RM 4.9
Proposed Action & Dredge and Slurry Alternative
Over 70 miles of high quality river and tributary habitat
Tribe Hatchery
State Fish Rearing Channel
Elwha Dam Site
RM 4.9
Lake Sutherland
Indian Creek
Glines Canyon Dam Site
RM 15
RM 25
RM 35

Elwha Dam has had a similar influence on habitat in the lower river. In its present condition, the Elwha's lower reach has limited salmon spawning and rearing areas due to shrinking gravel bars and fewer side channel habitats. There are 4.9 miles of degraded mainstem and side channel habitat in the lower reach.

Spawning gravel and large woody debris important for cover during the rearing period, is largely absent in both the middle and lower reaches of the river because of the dams. Particulate organic matter, required to sustain the invertebrates on which the fish feed, is present only in very low concentrations in both the lower and middle reaches, and water temperatures are 2° to 4° C higher on average during late summer and early fall than upstream of the dams.

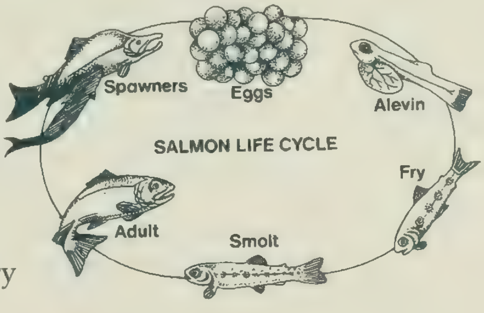
Flood control activities in the late 1940s and early 1950s likely hastened the loss of lower river habitat. Bulldozers were used to straighten the river channel and build dikes, thus increasing river flow energy and reducing backwater habitat.

Chinook Salmon. The middle reach of the Elwha River currently has 18.3 miles of potential mainstem and tributary habitat for chinook salmon above the Elwha dam (James River II 1988). In addition, approximately 51.5 stream miles (including 27 miles of mainstem), 2.5 miles of which is inundated by Lake Mills, would be available to chinook in the upper reach if the dams were not present. The upper reach and tributaries would provide excellent spawning habitat for chinook salmon (WDF 1971).

The best available data indicate that approximately 61% of the adult chinook returning to the Elwha River to spawn are intercepted in ocean fisheries (*Elwha Report*, p. 16). Although the total number of chinook returning to the Elwha has been as high as 8,600 fish (in 1988), this has decreased in recent years to fewer than 2,000 in 1993 and 1994. An estimated 2,900 chinook are forecast to return to the Elwha River in 1995 (PNPTC 1995). Many returning chinook die prior to spawning when river flows are low and water temperatures high during the late summer and early fall.

In-river chinook harvest remains restricted. No sport fisheries are allowed in the river, and harvest by the Lower Elwha Klallam Tribe during test fisheries is usually fewer than 100 fish per year, but was as high as 790 in 1988 (Hoines 1994).

Since 1982, chinook escapement (fish not harvested that are available to spawn) to the state spawning channel has been between 100 to 2,000 fish, peaking in 1988, and declining recently to the lowest levels on record. During the same time period, naturally spawning escapement has been 800 to 5,400 fish. A large portion of the natural spawners is taken for hatchery brood stock, and many of the hatchery



returns stray and spawn in the river rather than the rearing channel (PNPTC et al. 1993). Because of this crossover, the Elwha chinook run is managed as a single unit, i.e., returns to the hatchery and naturally spawning fish are combined to represent the total chinook escapement. In years of high escapement, limited spawning habitat creates crowded conditions for the spawning adults, with much higher density of redds (spawning nests) per river mile than in other streams (FERC 1993, p. 3–33).

Under the No Action alternative, natural chinook production would continue to decrease. Disease and genetic problems related to hatchery dependence would contribute to the loss of the naturally spawning stock. Fishing opportunities would likely become more restricted, potentially limiting all harvest of this stock. Water temperatures would remain elevated, contributing to disease and pre-spawning mortalities.

Coho Salmon. No action would limit coho to the lower 4.9 miles of the river. The dams have severely degraded the available coho habitat in the lower river. The Elwha's 4.9 miles of degraded mainstem and side channel habitat in the lower reach have limited coho salmon spawning and rearing areas due to shrinking gravel bars and fewer side channels. Large woody debris, important for cover during the rearing period, is largely absent in both the middle and lower reaches of the river because of the dams.

Like chinook, coho salmon are heavily harvested before arriving at the river mouth, with marine harvest rates commonly exceeding 65% (*Elwha Report*, p. 16). Reported in-river harvest by the Lower Elwha Klallam Tribe for the last 10 years (1985–1994) has been as high as 9,000 fish, but is usually in the range of 500–2,000 (NWIFC 1995). Annual sport harvest in the Elwha River has a daily limit of six fish/person. In 1992, the most recent year for which data is available, the Elwha sport catch was 368 fish (Zinicola 1994).

Under the No Action alternative the lower river habitat would be expected to further degrade. This stock would have to rely on artificial hatchery production to stay viable. Dependence on hatchery propagation would likely degrade the quality of the stock because of increased disease, potential inbreeding, and artificial selection pressures. Mechanical breakdowns and power outages at the hatchery facilities could further hamper survival.

Pink Salmon. Since the two dams block the transport of spawning gravel, habitat in the middle and lower reaches has been effectively eliminated for pink salmon. The substrate consists of embedded cobble that is of little use to spawning pink salmon. The traditional spawning grounds for pink and chum salmon are thought to be the first 16 miles of mainstem Elwha River and 9.7 miles of tributaries, such as Indian Creek and Little River. All but the lowest 4.9 miles of mainstem river are currently blocked by the dams.

Another potential factor affecting pink salmon production is the increased hatchery outplanting of juvenile coho, steelhead, and chinook, which may feed on newly emerged pink and chum salmon (Crain 1992; Fresh and Schroder 1987; Johnson 1973). Poor ocean conditions, little or no estuary habitat, and high water temperatures in the Elwha River also have adverse effects (WDFW et al. 1994).

There has been no hatchery program for Elwha pink salmon in the last several decades. Peak runs and escapement to the river since 1959 were nearly 40,000 (in 1963). Since 1979, however, estimated runs and escapement have been in the hundreds and since 1989 probably less than 5 fish annually (WDFW et al. 1994). In-river harvest of Elwha pink salmon has been negligible (two fish maximum) in the last ten years.

At present, this stock is thought to be at or near extinction. Under the No Action alternative, Elwha pink salmon would not recover.

Under the No Action alternative, Elwha pink salmon would not recover.

Chum Salmon. The historical upstream distribution of chum salmon is not known. However, chum are the poorest jumpers of all Elwha River salmon, and it is thought that chum used only the lower 16 miles of the river. Habitat in the middle and lower river is therefore particularly important to this species. Currently, the lack of spawning gravels in the lower river makes it largely unsuitable for chum, although they use side channel areas.

Since chum salmon rearing occurs mainly in the estuarine or marine environment, health of the Elwha River estuary may have played a particularly critical role in maintaining the population. The estuary is currently a fraction of its pre-dam size, primarily because the dams have held back sediments necessary to create and maintain it. Also, like pink salmon, increases in Elwha coho, steelhead, and chinook hatchery fish could have kept chum populations low through predation on juveniles.

During recent years, runs to the Elwha River have typically been less than 1,000 fish, with a peak of 1,500 in 1980. Reported tribal in-river harvest for the last 10 years has ranged from 820 to fewer than 50 fish per year. There has been no directed in-river harvest of chum since 1987. From 1988–92, incidental catch of chum during other river fisheries averaged just over 100 fish annually (Hoines 1995). Ocean and British Columbia harvest of Elwha River chum salmon is considered minor at less than 5% (WDF 1984).

Under the No Action alternative, natural propagation may maintain chum in the Elwha, but this stock's dependence on estuarine habitat, even after hatchery rearing, would continue to limit survival. Without hatchery intervention, this stock would likely become extinct.

Sockeye Salmon. All major stocks of sockeye require a river system with a connected lake. The only lake in the Elwha River drainage is Lake Sutherland, now inaccessible because of Elwha Dam. Harvest records (1982–1991) show an in-river harvest of only eight sockeye total over the ten-year period (Hoines 1994). These fish were probably strays and could have come from coastal

(Ozette or Quinault), Puget Sound (Baker or Lake Washington), or Fraser River runs.

Under the No Action alternative, sockeye in the Elwha River would not recover.

Steelhead. No Action would limit steelhead to the lower 4.9 miles of the river, eliminating over 93% of their historic range. Although the lower reach of the Elwha has little suitable steelhead spawning habitat, available rearing habitat may be the main factor currently limiting Elwha wild steelhead production in the lower river. Based on a model developed by Gibbons et al. (1985), the lower river can support approximately 200 spawning adult fish (James River II 1988).

Under the No Action alternative, natural production would continue to decline; eventually, all steelhead production would become dependent on artificial propagation. Hatchery dependence would impact fish because of disease, genetic problems, and breakdowns mentioned above.

Approximately 3,100 winter adults enter the river from an average of 82,000 hatchery smolts released each year (PSMFC 1995). A tribal in-river commercial fishery averages 1,450 fish per year (PNPTC and WDFW 1994). Sports anglers harvest an additional 1,150 winter and 355 summer steelhead on average each year (PNPTC and WDFW 1994).

Under the No Action alternative, sockeye in the Elwha River would not recover.

Very few steelhead are harvested in the marine environment, largely due to a lack of fishing effort in saltwater during their return migration period (December through April). Some interception of summer steelhead occurs in British Columbia, during their sockeye net fishery. The majority of Washington's commercial salmon fishery occurs in the fall months, well before steelhead enter these regional waters (Thom Johnson, per.comm., WDFW, October 20, 1995).

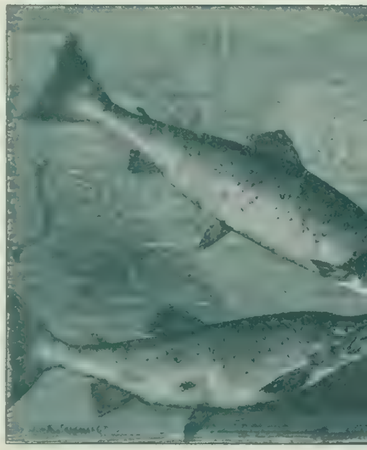
Steelhead also tend to stay close to the surface and near shore during their final marine migration, thus avoiding a majority of the commercial fisheries in Puget Sound and the Strait of Juan de Fuca (Gary Graves, per.comm., NWIFC, October 20, 1995).

Cutthroat Trout. Mainstem spawning substrate quality for cutthroat in the lower and middle reaches of the Elwha is generally poor because of the dams. The lower Elwha has limited small tributaries with low gradient areas. Habitat in the lower river, therefore, is less conducive to cutthroat trout production than more characteristic streams. Cutthroat densities in the lower river, i.e., the anadromous component of the stock, have declined during the last decade.

Under this alternative, numbers of cutthroat in the lower river would continue to decline or remain extremely low. Resident populations would continue where they are found presently in the middle and upper reaches of the Elwha River.

Char. This species is most often found in abundance only in systems with high gradient and very clean, cold water, which is characteristic of much of the Elwha River (pers. comm., Thom Johnson, WDFW, April 6, 1990).

An angler survey in 1974 and 1976 indicated that 45% of all fish captured in the Elwha upper reach were freshwater or resident native char. A 1975 survey of Lake Mills fish populations indicated that approximately 15% of the lake sport fish were native char, with an estimated population of 7,500 (Mausolf and Sundvick 1976), although the authors concluded that their survey probably overestimated lake fish populations. A creel survey conducted on Lake Mills, Lake Aldwell, and in the middle reach noted native char as a minor catch, although it did not state numbers of fish caught by species.



Like cutthroat, under the No Action alternative, the anadromous component of the stock would decline or remain at extremely low numbers. Resident populations would continue to exist where they are found presently in the middle and upper reaches of the Elwha River.

Resident Rainbow Trout and Sturgeon. Rainbow trout are the most abundant game fish in the river and reservoirs above Elwha Dam based on historical (Mausolf and Sundvick 1976) and recent surveys (Morrill and McHenry 1995; Collins 1983). A creel survey of sport catch in the two Elwha River reservoirs and intervening river indicated extensive use by fishermen (22,000 hours of fishing effort per summer season, Collins 1983). The dams have resulted in an increase in rainbow and other resident trout, as competition for food and habitat from anadromous species has been eliminated. Factors that may presently control rainbow populations below Glines Canyon Dam include poor spawning gravel quality, which would affect abundance, and low food supply which would affect fish growth and possibly survival.

Historical presence of sturgeon in the Elwha River is unknown. Factors controlling Elwha sturgeon population are not known. Compared to other major sturgeon producing streams, the Elwha River estuary is small and may limit sturgeon production.

Under the No Action alternative, resident rainbow trout would continue where they are found presently in the middle and upper reaches of the Elwha River. Estuary habitat would continue to provide only minimal habitat for sturgeon.

Conclusion

The Elwha Dam confines native anadromous fish to the lower 4.9 miles of river habitat and prevents their access to more than 70 miles of usable habitat in the middle and upper Elwha River. The two dams degrade habitat in the lower river by increasing water temperatures to levels that contribute to disease outbreaks, trapping large woody debris important for instream cover, reducing nutrient flow necessary for invertebrate (food) production, and trapping spawning-sized gravels essential for successful natural reproduction. The trapping of coarse sediment and nutrients also adversely affects the size and quality of the estuary near the river mouth, which serves as a nursery for juvenile salmonids. In addition, the lack of bedload in the lower river prevents the formation of side channel habitat used by chum for spawning and coho for rearing.

The No Action alternative would have a major long-term adverse impact on fisheries. This alternative would provide no chance of restoring native anadromous fish in the Elwha River and cause the genetic integrity of the existing native stocks to deteriorate because of continued use of hatchery stocks. There would be no new wild production of native anadromous fish, and hatcheries would continue to provide the vast majority of Elwha anadromous fish. Existing stocks in the lower river unsupported by artificial propagation would likely decline to extinction.

Impacts of Proposed Action – River Erosion Alternative

Restoration Potential

Both the River Erosion (proposed action) and Dredge and Slurry alternatives would result in major beneficial long-term impacts on salmonid habitat. Transport of sediment would be reestablished along the entire river, increasing the quality and quantity of spawning habitat. Temperatures would be reduced in the middle and lower river to pre-dam levels, the middle and lower reaches would be fully supplied with woody debris, and nutrient flow to the upper reach via salmon carcasses would be restored.

Temperatures would be near levels considered optimum to the well being of trout and salmon. The nutrients would support the invertebrates on which most species of native anadromous fish feed. Woody debris would influence important river habitat characteristics such as riffle/pool complexes, substrate type and location, and cover. These physical aspects often determine salmonid spawning, nursery, feeding, and winter sites.

Female coho digging a nest to deposit her eggs, with male nearby. (Natalie Fobes photo)

Native anadromous fish would again be able to spawn upstream of the dams, as access to the 93% of the river with 70 miles of high quality mainstem and tributary habitat, lost when the two dams were built, would be restored.

As a result of improvements to habitat and restored access, dam removal would substantially increase wild production of salmon and steelhead. Recovery levels predicted for the six major salmon and steelhead runs in the Elwha River (summer/fall chinook, coho, chum, pink, winter steelhead, and summer steelhead) are summarized and compared to No Action in table 44. Wild production estimates for the remaining anadromous salmonid species (spring chinook, searun cutthroat, and char) were

Table 44. *New Wild Salmonid Production and Recovery Time (number of fish/year)*

	ACTION ALTERNATIVES (FULL RESTORATION)		NO ACTION[a] (EXISTING CONDITIONS)
	Number of Fish	**Years to Recovery**	**Number of Fish**
Chinook	31,000	21-25	1,500-2,000[b]
Coho	35,000	15-18	<500
Pink	274,000	16-20	0
Chum	36,000	18-21	<200
Steelhead	10,000	15-18	<500
Sockeye	6,500	12-20	0

[a] No Action (existing conditions) would not result in any new wild salmon or steelhead. These figures are estimates of current production of wild anadromous fish in the Elwha River. Wild chum would likely decline to 0 in time.

[b] All Elwha chinook are considered a composite of wild and hatchery stocks.

not determined because of insufficient data. Full production would occur after three to five "cycles" (from hatching to spawning) for most species. However, the Ricker model does not include the use of hatchery outplants, which would decrease the restoration duration.

Reintroduction of native anadromous trout and salmon would increase competition for available food and habitat, resulting in the decline of resident salmonid populations (rainbow trout, native char, and cutthroat trout) to historically reduced population levels. However, this loss would be offset through improved habitat and the increased number of native anadromous trout and salmon.

Interior's programmatic environmental impact statement showed that nine out of ten runs of native Elwha River anadromous fish would have good or excellent chances for restoration if both dams were removed (see table 45). The analysis indicated this was because mortality from passing over the dams (other alternatives proposed passage measures) would be eliminated and habitat along the entire river would be restored or accessible. Because all action alternatives in this EIS assume dam removal occurs, passage is assured for all species. Therefore the focus is on stock availability and habitat.

Species Specific Restoration Potential

All runs for which native stock are readily available have excellent chances for restoration, including winter steelhead and summer/fall chinook salmon. Chances for restoring coho are good to excellent, and good for all remaining runs except sockeye salmon. Sockeye restoration would rely on the existing kokanee population in Lake Sutherland, so restoration prospects are rated poor to fair. Stock availability and habitat factors used to determine restoration

Table 45. *Restoration Potential of Elwha Salmonids — River Erosion Alternative (Proposed Action)*

RUN	STOCK AVAIL.	ABILITY TO WITHSTAND FISHING PRESSURE	FISH PASSAGE	HABITAT QUANTITY & QUALITY	SALMONID RESTORATION POTENTIAL
Summer/Fall Chinook	F	F	F	F	excellent
Spring Chinook	U/M	F	F	F	good/excellent
Coho Salmon	M	M	F	F	excellent
Pink Salmon	U/M	F	F	F	good
Chum Salmon	M	F	F	F	good
Winter Steelhead	M/F	F	F	F	good
Summer Steelhead	M	F	F	F	good
Sockeye Salmon	U/M	F	F	U/M	poor/fair
Searun Cutthroat	unknown	F	F	F	good
Searun Char	M	F	F	F	good

F = Favorable, M = Marginal, U = Unfavorable

potential for each species are discussed below. Fishing pressure is summarized under Impacts of No Action.

Chinook Salmon

Stock Availability. A suitable stock of summer/fall chinook is presently available, and is maintained in Washington Department of Fish and Wildlife hatchery facilities. However, a separate spring entry of spring chinook could be missing altogether in the Elwha River. The genetics of Elwha spring chinook presumably remain intact in the summer/fall stock (Brannon and Hershberger 1984); this is supported by the fact that chinook are seen in the river as early as June 1. Fully restoring the summer/fall run and making spring chinook habitat available upstream of river mile 34 is considered likely to result in separation of the two stocks.

Habitat. The middle reach of the Elwha River has 18.3 miles of potential mainstem and tributary habitat for chinook salmon above the Elwha Dam (James River II 1988). In addition, approximately 51.5 stream miles (including 27 miles of mainstem), 2.5 miles of which is inundated by Lake Mills, would be available to chinook in the upper reach. The upper reach provides excellent spawning habitat for chinook salmon, both in the mainstem river and major tributaries, i.e., Cat, Godkin, and Delabarre creeks (WDF 1971). Other tributaries, such as Goldie Creek, also contain suitable spawning habitat (James River II 1988).

Ricker models predict the return of more than 31,000 chinook within 21–25 years (see table 44) with no hatchery outplanting. Adding outplanting and other measures described below could reduce the time to restore chinook and all other runs analyzed in this report by one-half.

Coho Salmon

Stock Availability. The indigenous coho salmon stock has been largely maintained on the river, although out-of-basin coho salmon have been introduced into the Elwha River a number of times. The Washington Department of Fish and Wildlife outplanted coho from the Dungeness River from 1967 to 1976. Stocks used after 1977 were collected from the Elwha. Some coho were reared and released at the state rearing channel from 1974 to 1982. The Lower Elwha Klallam Tribal Fish Hatchery has been used for coho rearing since 1977 and has been the only source of hatchery coho to the river since 1983.

Habitat. Similar to chinook, approximately 48.8 stream miles of habitat are potentially available to coho in the upper reach. Carlson Falls may be more difficult for coho to pass because of their expected run timing in fall and early winter. For coho that cannot pass the falls, 32.0 miles of stream would be available (James River II 1988). Approximately half of the available stream miles are tributary streams suitable for coho spawning. Not all areas would support coho rearing because of their high slopes (greater than 3%). Two and one-half miles of mainstem river are inundated by Lake Mills; this section would become prime coho spawning and rearing habitat if the Glines Canyon Dam were removed.

The quality and quantity of potential habitat for coho are degraded and limited in the mainstem middle reach because the Glines Canyon Dam has held back the smaller gravels that coho require for spawning (James River II 1988; WDF 1971). In addition, the 2.8 miles of mainstem river inundated by Lake Aldwell are wholly unavailable for spawning. If sediment transport was restored, spawning areas would be replenished, leading to more channel meandering and the creation of pool and side channel habitat that coho need to successfully rear. Nine and 7/10 miles of potential tributary habitat and an additional 8.6 miles of mainstem habitat in the middle reach (James River II 1988) would become accessible if the dams were removed.

With no outplanting or hatchery influence, Ricker models predict peak production of 35,000 coho in as few as five cycles (15–18 years). Outplanting could reduce the restoration period by as much as one-half.

Pink Salmon

Stock Availability. Elwha River pink salmon are considered to be in the same "evolutionarily significant unit" as indigenous Dungeness River pink salmon. This determination of genetic similarity allows the use of the Dungeness pink stock as an appropriate brood source to restore Elwha pink salmon.

Habitat. The traditional spawning grounds for pink and chum salmon are thought to be the first 16 miles of mainstem Elwha River and 9.7 miles of tributaries, such as Indian Creek and Little River. It is unknown whether areas farther upstream were utilized by pink salmon.

Restoring access could support an estimated 274,000 pink salmon in 16–20 years, if the dams were removed. Outplanting or hatchery supplements could reduce restoration time by as much as half.

Chum Salmon

Stock Availability. Despite a previous stocking program, recent genetic stock identification by the Lower Elwha Klallam Tribe and the US Fish and Wildlife Service indicates that early returning chum in the Elwha are probably direct descendants of Elwha River native stock (FWS 1995d).

Habitat. The lack of spawning gravels in the lower river makes it largely unsuitable for chum, although they do use side channel areas. Removing Elwha Dam would provide access to suitable spawning habitat in the middle river, 8.6 miles of mainstem habitat, including 2.8 miles of currently inundated habitat, and 9.7 miles of tributary habitat. Removing Glines Canyon Dam would restore transport of gravel needed by chum to effectively utilize mainstem habitat in the middle and lower reaches. Habitat currently inundated by Lake Mills (2.5 miles) would also be accessible.

Removing the dams would result in an estimated 36,000 chum returning annually to the Elwha River in 18–21 years. Outplanting or hatchery supplements could reduce restoration time by as much as half.

Sockeye Salmon

Stock Availability. Elwha River sockeye salmon are probably extinct, although some Lake Sutherland kokanee, a land-locked sockeye salmon, may be descended from Elwha sockeye. If so, these would serve as suitable stock for restoration.

Habitat. Even though dam removal would restore sockeye access to Lake Sutherland, the lake itself would remain in a developed and degraded condition. Sockeye would probably spawn in the shallow parts of the lake, Indian Creek or in a tributary that feeds into the lake.

Assuming a viable brood, 6,500 sockeye could return to the Elwha in 12–20 years without help from hatchery outplanting. Time to restore sockeye could be reduced by half if outplanting were part of the restoration plan.

Steelhead

Stock Availability. The Elwha has been stocked with hatchery steelhead since 1965, but a native Elwha River winter steelhead remains; it is identified by its later entry than the hatchery stock, February through April, into the river. Although this native winter steelhead is differentiated from hatchery stock by its late entry, the summer steelhead stock is not as easy to identify since

there is no apparent seasonal separation of transplanted, nonnative hatchery stock. Rainbow trout from the Elwha River above the dams produce smolts that could be used to restore a summer steelhead run. These rainbow are native and may be freshwater descendants of summer or winter steelhead (Reisenbichler and Phelps 1989).

Habitat. An estimated 15.7 miles of inaccessible steelhead habitat in the middle reach, 5.8 miles of mainstem habitat (2.8 miles of which are under Lake Aldwell), and an additional 9.9 miles of tributaries, could be suitable steelhead spawning habitat if the dams were removed. Since steelhead typically spend two years in fresh water before migrating to the ocean, rearing habitat is particularly important and is often the limiting factor in their production. Much of the mainstem and major tributaries in this reach would provide good rearing habitat for steelhead.

In the upper reach, steelhead able to pass the Carlson Canyon Falls would have access to 50.4 miles of river and stream habitat. Steelhead would have the least trouble of all the salmon and trout species in ascending upriver areas (James River II 1988). The upper reach has excellent spawning and rearing habitat, and an additional 2.5 miles of mainstem habitat now inundated by Lake Mills would be recovered with the removal of Glines Dam.

Within 15–18 years and assuming no help from hatchery outplanting, more than 10,000 steelhead would return to the Elwha if the dams were removed. If outplanting and hatchery supplements were used, the time to restore steelhead could drop by half.

Cutthroat Trout

Stock Availability. It is unknown whether a native, seagoing stock is still present in the lower river. The few encountered in the lower river may be strays from other systems. Some resident cutthroat apparently retain the ability to produce juveniles that resume anadromous behavior and, in fact, may be descendants of the original Elwha searun stock. These resident populations may reestablish seagoing runs of cutthroat trout, once passage is restored.

Habitat. Searun cutthroat trout typically spawn in small or moderate streams with low stream gradients (Trotter 1989). Spawning habitat in the lower Elwha is probably limited because of the low number of gently sloping tributaries and lack of spawning gravel. Low gradient tributaries in the middle and upper Elwha could provide spawning habitat for searun cutthroat.

Char

Stock Availability. Anadromous native char have not been identified with certainty in the lower reach, but are likely present since they are found in all major coastal drainages in Washington (Wydoski and Whitney 1979). Like cutthroat, the genes for anadromy probably remain intact in the resident population, and resident char would provide a suitable source of stock to restore anadromous Dolly Varden and bull trout.

Habitat. This species is most often found in abundance only in systems with low gradient and very clean, cold water, which is characteristic for much of the Elwha River (pers. comm., Thom Johnson, WDFW, April 6, 1990).

Ratings for the four factors considered in determining the restoration potential of each stock under the proposal are summarized in table 45.

Resident Rainbow Trout and Sturgeon

The return of native anadromous fish to the Elwha River would increase competition for available food and habitat. Resident populations would be expected to decline to historically low population levels. It is unknown whether dam removal would affect sturgeon, although the expected increase in growth in the Elwha estuary may provide habitat for this species.

Short Term Impacts of Dam Removal

Under the proposed action, river erosion of reservoir areas would result in short-term high suspended sediment concentrations and turbidity. The high sediment loads would cause moderate short-term habitat degradation and direct losses of fish in the middle reach. More severe impacts, including avoidance by immigrating adults, would be seen in the lower river. The highest levels would coincide with each notch opening during dam removal and subsequent flood flows (see Alternatives chapter, Dam Removal and Sediment Management sections). Since fine sediment is expected to wash downstream quickly, that available for transport from the reservoir areas would rapidly decrease following dam removal. Some increases in suspended sediment concentrations and turbidity would be expected with high flows in the years following dam removal, but the portion attributable to fines from reservoir areas would decline with each subsequent high flow.

Between 4.9 and 5.6 million cubic yards of fine sediment would be released during and following dam removal, adversely affecting 16 miles of fish habitat from the upper end of Lake Mills to the river mouth for up to four years; however, sediment releases would be intermittent and of decreasing duration following dam removal. Peak concentrations of suspended sediment could exceed 50,000 parts per million during high flows or during drawdown. Between 1 and 3 million cubic yards of sand and coarser material also would be released from the reservoirs, causing abnormal bedload concentrations.

Modeling (BOR 1995f) showed that the reservoir drawdown period would last an estimated 500 to 600 days, during which suspended sediment concentrations would exceed 200 parts per million 60% to 70% of the time, 1,000 parts per million 40% to 60% of the time, and 10,000 parts per million 1% to 6% of the time (milligrams per liter and parts per million are nearly equivalent for concentrations up to 10,000 parts per million). While the dams were being removed, there would be three long periods of high sediment concentration separated by two periods of low sediment concentration. Following complete dam removal, two or three large spikes of suspended sediment concentration would be anticipated; these would be likely to occur during the high flows of the first fall or winter after dam removal.

Direct exposure to these high suspended sediment concentrations for extended periods would adversely affect fish in the lower Elwha, and fish mortalities would be expected. Many studies have assessed the effects of fine sediment on salmonid populations. Direct effects of suspended sediments on fish begin to be observed between 50 and 100 milligrams per liter, while lethal and sublethal effects from acute exposure (less than four days) occurred at concentrations of 10,000 to over 100,000 milligrams per liter and from chronic (six weeks or more) exposure up to 1,000 milligrams per liter (Herbert and Merkens 1961; EIFAC 1965; Noggle 1978; Alabaster and Lloyd 1982; Berg 1982; McLeay et al. 1984, 1987; Simmons 1984; Sigler et al. 1984; Berg and Northcote 1985; Lloyd 1985, 1987, Lloyd et al. 1987; Chapman and McLeod 1987; Newcombe and MacDonald 1991). Chronic exposures to concentrations greater than 100 milligrams per liter impaired feeding and caused reductions in growth rates, avoidance, and downstream displacement. Adult anadromous fish may avoid concentrations greater than 350 milligrams per liter, impeding upstream migrations (Brannon et al. 1981, Whitman et al. 1982). Stress, as measured by changes in blood chemistry, was reported in fish exposed for short periods to sediment concentrations as low as 50 milligrams per liter (McLeay 1983).

Despite evidence of adverse effects from high concentrations of suspended sediment, fish often thrive in naturally turbid environments. Some of the largest salmon-producing rivers on the Pacific Coast are turbid (Squamish River, Levy and Levings 1978; Taku River, Murphy et al. 1989; Fraser River, Northcote and Larkin 1989). Salmon occupy these systems for a large portion of their early life. Some researchers believe high turbidity may benefit juveniles by providing protective cover from sight-feeding predators (Gregory 1993).

The Elwha River was an abundant producer of salmon and trout before the dams were built, yet has natural suspended sediment concentrations during high flows averaging 300 to 400 milligrams per liter with short-duration peaks greater than 1,200 (based on sediment data from the upper reaches).

Salmonid populations exposed to the most extreme sediment conditions have shown remarkable resiliency. For example, the May 18, 1980, eruption of Mount St. Helens caused a debris flow that sent an estimated 3 billion cubic yards of material into the upper 17 miles of the North Fork Toutle River basin and approximately 50 million cubic yards into the South Fork Toutle River (Lucas 1985). Approximately 90% of the upper North Fork and tributaries previously accessible to salmon were buried up to 213 yards deep by mud flows. Riparian vegetation, important to fish because it shades streams and keeps water temperatures cool, was completely wiped out in the Toutle. In contrast, the most sediment expected to be released from the two Elwha reservoirs is 5.6 million cubic yards, and existing riparian vegetation along the Elwha would be unaffected by the proposed action.

The eruption devastated most of the anadromous fish habitat in the Toutle River. Initially, many adult salmonids avoided entering it because of high sediment loads and strayed to other Columbia River tributaries (Lucas 1985). However, natural fish recovery began quickly. The first adult summer steelhead was observed in the North Fork Toutle River in August 1980, only three months after the eruption. Steelhead redds (spawning nests) were observed in a North Fork and many South Fork Toutle River tributaries. Fry (juveniles) were later captured in these tributaries, indicating successful reproduction (Rawding 1995). The numbers of yearling and older steelhead increased tenfold from 1981 to 1984 in a South Fork tributary (Lucas 1985). Despite the devastation wreaked on the Toutle River anadromous fishery by the eruption, recovery began immediately and continues today. Compared with the proposed action, conditions in the Elwha River, even under the worst of circumstances for short-term impacts to fish, would be far better and restoration expected to occur much more quickly.

For purposes of this analysis, three suspended sediment concentration thresholds were set at levels that 1) cause physiological stress, reduced growth, and avoidance (200 parts per million), 2) are lethal from chronic exposure (1,000 parts per million), and 3) are lethal from acute exposure (10,000 parts per million). Then, using simulation results, the number of days and time of year when these thresholds would be exceeded were determined (table 46).

The impacts on returning (adult) anadromous trout and salmon vary depending on the timing of their entry to the river. Construction would be stopped during specific periods of the year for safety reasons and to accommodate adult inmigration.

Since resident fish are present in the river all year, they would be affected in each period noted above. However, those in the middle river would have access to clean water tributaries unaffected by dam removal, and many could avoid high suspended sediment levels. Resident populations above Lake Mills would be unaffected.

In addition to turbid water effects on fish, abnormally high amounts of bedload sediments would temporarily change river bottom habitat. Shifting fine and coarse material would be prominent over much of the stream substrate from Lake Mills to the river mouth until after the dams were completely removed and major erosion of reservoir bottom sediments diminished. However, the fine-grained sediment would not embed most bottom substrate because the river gradient is sufficient to maintain rapid turbulent flows to carry the finer material to the Strait of Juan de Fuca. Depending on hydrologic conditions, spawning, rearing, and feeding habitat conditions would rapidly improve after completion of dam removal as the river channel became more stable and contained less fines. Natural production in the Elwha River below Lake Mills would be limited during the years of high sediment yield — for a period of up to four years. Fine material deposited on the river bottom would cause

Table 46. *Impacts of Suspended Sediments on Adult Anadromous Salmonids — River Erosion Alternative (Proposed Action)*

SOURCE OF IMPACT	TIME OF IMPACT	SUSPENDED SEDIMENT CONCENTRATIONS AND DURATION	IMPACTS	STOCK MOST LIKELY TO BE AFFECTED
Begin dam removal and lake drawdown	Starting in June, year 1	123 to 217 days more than 200 ppm 52 to 170 days more than 1,000 ppm 0 to 26 days more than 10,000 ppm Extremes of 6,700 to 43,000 ppm	Direct losses of fish from Lake Mills to mouth due to chronic or acute exposure. Avoidance and straying of returning adults.	Chinook, coho, pink salmon, and steelhead, and char
Stop dam removal during winter floods	Typically starting in November, year 1	20 to 85 days less than 200 ppm (close to background levels)	Adult fish would enter river for spawning and capture.	Chum and coho salmon; steelhead and cutthroat trout
Continue dam removal after winter floods	Typically starting between Dec., year 1 and Feb., year 2	20 to 126 days more than 200 ppm 20 to 83 days more than 1,000 ppm 0 to 2 days more than 10,000 ppm Extremes of 5,600 to 11,000 ppm	Direct losses of fish from Lake Mills to mouth due to chronic exposure. Avoidance and straying of returning adults.	Coho salmon and steelhead
Stop dam removal during spring floods	Starting in April or May, year 2	80 to 100 days less than 200 ppm (close to background levels)	Juveniles would migrate from the unaffected upper reaches to the Strait. Adult steelhead and spring chinook would enter the river.	Spring chinook and steelhead
Complete dam removal after spring floods	Starting in July and lasting to late Oct., year 2; or to Feb., year 3	90 to 111 days more than 200 ppm 87 to 108 days more than 1,000 ppm 3 to 25 days more than 10,000 ppm Extremes of 15,000 to 51,000 ppm	Direct losses of fish from Lake Mills to mouth due to chronic or acute exposure. Avoidance and straying of returning adults.	Chinook, coho, chum, and pink salmon and steelhead
After dam removal high flows erode fine reservoir sediments	Winters & springs between Nov. year 2 to Sept. year 4	At least two 1 to 2 day periods with more than 10,000 ppm Extremes of 20,000 to 40,000 ppm.	Some direct losses of fish.	Chum and coho salmon and winter steelhead

egg losses because of less intra-gravel flows, low oxygen, and burying. Juvenile fish would be affected by the reduction of prey (aquatic insects) and by the filling of pools and areas between cobble and boulders that provide important cover habitat for fish. A summary of impacts of dam removal, hatchery support, and outplanting on each run is presented in table 47.

Mitigation and Restoration Actions

Hatchery support, outplanting, harvest management, and optimal timing of dam removal would help protect anadromous fish populations during the dam removal process and accelerate restoration (see the Alternatives chapter and appendix 2 for a detailed description of these restoration measures). These actions are required both to meet the restoration goals set out by the Elwha Restoration Act and to comply with state of Washington regulations (*State Hydraulic Code*).

Hatchery support, outplanting, harvest management, and optimal timing of dam removal would help protect anadromous fish populations...

Hatchery Support and Outplanting . Hatchery support and outplanting would ensure protection of fish stocks during periods of high sediment yields (table 47 and appendix 2). The focus would be on collecting adult fish before and during dam removal to protect each year class of fish, even if juvenile fish were lost during the dam removal phase. The hatcheries would be used to provide a clean water refuge from the sediment laden river for chinook, coho, chum, and pink salmon, and winter steelhead broodstock. Consequently, water quality for the tribal hatchery would be protected. Measures to keep water yield and quality high during dam removal are discussed in the Impacts to Surface and Groundwater sections of this document. Production at the state rearing channel would have to be located at another facility for one to two years (see Water Quality section).

Also, hatchery-produced eggs and juveniles would be outplanted in upper river habitat unaffected by the release of reservoir sediments. Although dam removal would be timed to reduce impacts to juveniles outmigrating from the upper river, some losses in the lower reaches would be expected due to high suspended sediment concentrations. Outplanting would begin up to two years before dam removal. This would result in adults returning to the upper reaches immediately after the dams were removed.

Juvenile outplanting of most fish stocks in the upper basin would also accelerate the reintroduction of anadromous fish to the upper river compared with natural recolonization. It would also permit, in certain cases, selective reintroduction of stocks that might be better suited to sustained natural production in the Elwha River than those presently in the lower river. In other words, increased production would be expected because wild fish typically do better than hatchery fish in a natural environment.

Harvest Management. Fisheries impacting the Elwha sources would be managed by appropriate agencies to help achieve restoration objectives. Harvest rates of fish presently supported by hatchery production (summer/fall chinook salmon, coho salmon, winter and summer steelhead) would be phased down, if necessary, to ensure restoration of wild stocks. Lower harvest would allow more adult fish to return to the Elwha River to spawn, resulting in higher natural fish production.

Timing. To reduce losses of fish caused by the release of sediments, the notching phase of dam deconstruction would be timed to coincide with low fish-use periods. No notching would be done from mid-November to mid-December, as this is the time when coho and chum adults enter the river. A construction shutdown in the spring (April or May) would be timed to coincide with the natural steelhead return. Fisheries restoration needs, as well as those to protect water quality and minimize flooding would also help dictate adjustments to the rate of notching and, hence, to sediment delivery. Providing low sediment periods during dam removal would increase survival of migrating juveniles and spawning adults and thus increase natural fish production.

Revegetation of Lakebottom Sediments. The seeding of grasses and forbs, planting of trees, and some strategic placement of large woody debris are planned to help stabilize reservoir sediments and reduce the amount and duration of sediments transported. Reclaimed banks would support vegetation, which would provide nutrients and cover in the form of overhanging vegetation and woody debris, resulting in increased natural fish production.

Management of Excess Woody Debris. Large amounts of woody debris have been trapped by the dams and accumulated on the reservoir bottoms. After removal of the two dams, any unnatural accumulations of woody debris that could create fish barriers by jamming the river channel or cause other problems would be monitored. Remedial actions to ensure fish passage could include cutting and/or moving the debris.

Cumulative Impacts

Over-harvest, warmer than normal waters caused by El Niño, logging, development, water diversions, agricultural activities, removal of riparian vegetation, and bank hardening to protect roads and private and public property all have a cumulative, or additive, effect on fisheries. The biggest impact to Elwha River fisheries, however, has been the loss of 93% of the historic fish habitat and habitat degradation of the remaining accessible 4.9 miles after the Elwha Dam was built in 1910.

Dwindling populations of salmon in spots along the entire West Coast are largely because of habitat loss or degradation. Most small streams on the West Coast have been damaged from urbanization, water withdrawals, or other land management activities (Nehlsen et al. 1991). This is true with the large rivers, as well. Very few pristine watersheds are left in the United States.

In contrast, the area above Lake Mills provides pristine spawning and rearing habitats because it has been spared the adverse, long-term impacts from recent timber harvest, water use, and human development that many other Peninsula streams are now experiencing.

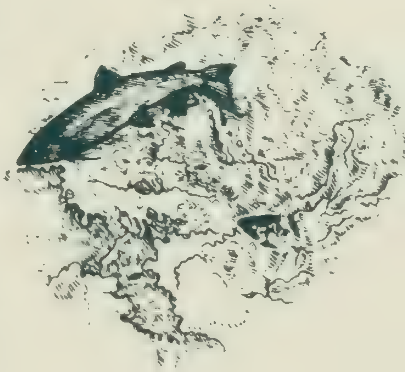
The impact of these actions is evident in reduced catches and the more frequent listing of anadromous fish species as threatened or endangered. As an example, the National Marine Fisheries Service recently (March 1995) proposed that wild steelhead runs from the Klamath River, California, north to Port Orford, Oregon, be listed as threatened under the Endangered Species Act because of

Table 47. *Summary of Short-Term Impacts on Anadromous Salmonids — River Erosion Alternative (Proposed Action)*

	SHORT-TERM IMPACT OF DAM REMOVAL	RESTORATION ACTIONS		SHORT-TERM EFFECT OF RESTORATION ACTIONS
		BROOD PROTECTION OR DEVELOPMENT	OUTPLANTING	
Chinook Salmon	Direct fish loss caused by extreme sediment levels	Move eggs from state fish hatchery affected by extreme sediment conditions to out-of basin facilities	Outplant juveniles to acclimation sites in the middle and upper Elwha River	Replace fish lost to high sediment levels; begin to reestablish chinook in the middle and upper Elwha River
Coho Salmon	Direct fish loss caused by extreme sediment levels	Use tribal hatchery to maintain coho brood run and safeguard the stock	Outplant eggs/fry to upper Elwha River starting before dam removal; release smolt	Replace fish lost to high sediment levels; begin to reestablish coho in the middle and upper Elwha River
Pink Salmon	Direct loss, if pinks present, caused by extreme sediment levels	Support restoration of depressed Dungeness stock to levels sufficient to allow export to the Elwha River	Outplant Dungeness pink salmon	Begin to reestablish pink salmon in the Elwha River
Chum Salmon	Direct fish loss caused by extreme sediment levels	Move adults/eggs out of lower river to nearby streams or hatcheries; establish brood run at tribe hatchery	Outplant eggs/juveniles into tributaries, side channels, and/or middle and upper Elwha River starting before dam removal	Reduce fish loss caused by high sediment levels; replace young fish lost to high sediment levels; begin to reestablish chum in the middle and upper Elwha River
Sockeye Salmon	No direct fish loss	No actions to develop brood; remove Lake Sutherland outlet screens and possibly restore passage via Indian Creek to regain sea access	No outplanting	No hatchery or outplanting effects; the existing Lake Sutherland kokanee population may eventually reestablish a native sockeye run
Steelhead	Direct fish loss caused by extreme sediment levels	Collect late run brood and raise juveniles	Outplant juveniles in upper Elwha River	Reduce fish loss caused by high sediment levels; replace young fish lost to high sediment levels; begin to reestablish steelhead in the middle and upper Elwha River
Searun Cutthroat and Char	Direct fish loss caused by extreme sediment levels	No actions to protect or develop brood	No outplanting	No hatchery or outplanting effects; natural recolonization by remnant stocks would eventually reestablish anadromous populations

population declines. Degradation of habitat caused by dams and water withdrawals has led to listings as threatened or endangered of salmon stocks in the Columbia River basin and Sacramento River in California.

Salmon and anadromous trout, including those that can outmigrate from the Elwha River, are impacted in the marine environment as well by commercial fishing pressure and environmental changes such as El Niño. Some Elwha River chum (5 to 15%), and larger portions of chinook (60%) and coho (approximately 77%) are taken by commercial and sport marine anglers before they return to the Elwha River.



The impact extends beyond the border since Pacific Coast fish produced in one area not only traverse the waters of many states, but are captured by Canadian anglers as well. United States anglers capture fish produced in Canada. Because of this, harvest is managed on the international (Pacific Salmon Treaty) level and on national (Pacific Fisheries Management Council) and local (state of Washington and treaty tribes) levels. The numbers of fish of United States origin caught by Canada are controlled by the Pacific Salmon Treaty. The purposes of the treaty are to "prevent overfishing and provide for optimum production" and to "provide for each Party to receive benefits equivalent to the production of salmon originating in its waters."

High seas drift net fisheries, which have had a large impact on Pacific salmon fisheries were banned internationally on December 31, 1992. Fishing vessels, closely monitored by the US Coast Guard and Canadian Pacific Maritime Forces in 1993 and 1994, committed very few violations of the ban. Today (1995) there is no high seas driftnet fishing affecting North American salmon stocks.

Regional, national, and international fisheries management has helped to prevent overharvest of most stocks, although this sometimes occurs. Additional regional harvest reductions to protect runs would likely be sufficient to help restore the Elwha River if the dams are removed. However, most population declines of these fish are due to diminished and degraded habitat.

Conclusion

The proposed action would allow for the full restoration of native Elwha River anadromous fish. The release of fine sediment caused by the removal of the two dams would have a temporary but major adverse impact on trout and salmon and their habitat below the dams for up to four years. However, hatchery support, outplanting, harvest management, and optimal timing of dam removal would help protect anadromous fish populations during this period and accelerate full restoration.

Impacts of the Dredge and Slurry Alternative

Restoration Potential

Restoration potential would be the same as for the River Erosion alternative (proposed action) except that full recovery would be achieved in slightly less time. Although more fish would probably survive and migrate during the two-year dam removal phase, this alternative would only slightly reduce the time to full recovery of native salmon and trout because of measures detailed in the fish restoration plan (appendix 2) and summarized below.

Short-term Impacts of Dam Removal

Short-term impacts would be of lesser magnitude and shorter duration than under the River Erosion Alternative (the proposed action). Approximately 75% less fine sediment would be expected to be released (1.2 to 1.4 million cubic yards) into the Elwha River.

Simulation results (BOR 1995f) for this alternative were similar to the proposed action but with lower suspended sediment concentrations. The total duration of high suspended sediment levels would be similar to the proposed action, lasting an estimated 500 days. However, the length of time that suspended sediment threshold concentrations were exceeded would be reduced. Suspended sediment concentrations would exceed 200 parts per million 20% to 60% of the time, 1,000 parts per million 10% to 25% of the time, and 10,000 parts per million less than 1% of the time, as opposed to suspended sediment concentrations that would exceed 200 parts per million 60% to 70% of the time, 1,000 parts per million 40% to 60% of the time, and 10,000 parts per million 1% to 6% of the time for the proposed action (table 48).

Like the proposed action, three periods of high sediment concentration would be separated by two periods of low sediment. The two low sediment periods would last longer than for the proposed action and allow more migrating adults and juveniles to move through the affected lower reach. Sediment concentrations during the three high sediment periods might be below lethal levels, and direct losses of fish would likely be less than for the proposed action. Generally, however, the same runs of fish would experience the same types of impacts during the phases of dam removal as in the proposed action. These impacts are summarized in table 49.

The impacts on river substrate and fish habitat caused by abnormally high amounts of bedload would be similar to the proposed action since the amount of coarser material released would be the same. Depending on hydrologic conditions, spawning, rearing, and feeding habitat, conditions would rapidly improve after completion of dam removal as the river channel became more stable and contained less fines.

Mitigation and Restoration Actions

Impacts of restoration actions would be the same as the proposed action except for the addition of the dredge and slurry pipeline, which would reduce impacts

Table 48. *Impacts of Suspended Sediments on Adult Salmonids — Dredge and Slurry*

SOURCE OF IMPACT	TIME OF IMPACT	SUSPENDED SEDIMENT CONCENTRATIONS AND DURATION	IMPACTS	STOCK MOST LIKELY TO BE AFFECTED
Begin dam removal and lake drawdown	Starting in June, year 1	79 to 179 days more than 200 ppm 7 to 76 days more than 1,000 ppm 0 to 1 day more than 10,000 ppm Extremes of 1,700 to 11,000 ppm	Possible direct losses of fish from Lake Mills to mouth due to chronic exposure. Avoidance and straying of returning adults.	Chinook, coho, pink salmon, steelhead, and char
Stop dam removal during winter floods	Starting in November, year 1	20 to 119 days less than 200 ppm (close to background levels)	Adult fish would enter river for spawning and capture.	Chum and coho salmon; steelhead and cutthroat trout
Continue dam removal after winter floods	Starting between December, year 1 and February, year 2	20 to 84 days more than 200 ppm 12 to 38 days more than 1,000 ppm 0 days more than 10,000 ppm Extremes of 1,700 to 2,700 ppm	Some losses of fish from Lake Mills to mouth due to chronic exposure. Avoidance and straying of returning adults.	Coho salmon and steelhead
Stop dam removal during spring floods	Starting in April or May, year 2	96 to 100 days less than 200 ppm (close to background levels)	Juveniles would migrate from the unaffected upper reaches to the Strait. Adult steelhead and spring chinook would enter the river.	Spring chinook and steelhead
Complete dam removal after spring floods	Starting in July and lasting to November year 2.	88 to 108 days more than 200 ppm 22 to 61 days more than 1,000 ppm 0 to 1 day more than 10,000 ppm Extremes of 3,900 to 13,000 ppm	Possible direct losses of fish from Lake Mills to mouth due to chronic exposure. Avoidance and straying of returning adults.	Chinook, coho, chum, and pink salmon and steelhead
After dam removal high flows erode fine reservoir sediments	Winter & springs between Nov. year 2 to Sept. year 4	0 days with more than 10,000 ppm 1 or 2 days with extremes of 5,000 to 7,600 ppm	Minor avoidance or stress.	Chum and coho salmon and winter steelhead

from fines. To protect fish during low flow periods, slurry pipeline operations would be temporarily stopped if needed to maintain sufficient river flows. Required flows would be above the once in ten year monthly minimum (table 16). Since peak turbidities would still exceed sublethal and lethal levels, the same measures to protect fish as in the proposed action would be imposed, i.e., hatchery support, outplanting, harvest management, and optimal timing of dam removal (see the Alternatives chapter and appendix 2 for additional information about fish restoration). Because impacts to fish would be less

Table 49. *Summary of Short-Term Impacts on Anadromous Salmonids — Dredge and Slurry Alternative*

	SHORT-TERM IMPACT OF DAM REMOVAL	RESTORATION ACTIONS		SHORT-TERM EFFECT OF RESTORATION ACTIONS
		BROOD PROTECTION OR DEVELOPMENT	OUTPLANTING	
Chinook Salmon	Possible direct fish loss caused by extreme sediment levels	Move eggs from state fish hatchery affected by extreme sediment conditions to out-of basin facilities	Outplant juveniles to acclimation sites in the middle and upper Elwha River	Replace fish lost to high sediment levels; begin to reestablish chinook in the middle and upper Elwha River
Coho Salmon	Possible direct fish loss caused by extreme sediment levels	Use tribal hatchery to maintain coho brood run and safeguard the stock	Outplant eggs/fry to upper Elwha River starting before dam removal; release smolt	Replace fish lost to high sediment levels; begin to reestablish coho in the middle and upper Elwha River
Pink Salmon	Possible direct loss, if pinks present, caused by extreme sediment levels	Support restoration of depressed Dungeness stock to levels sufficient to allow export to the Elwha River	Outplant Dungeness pink salmon	Begin to reestablish pink salmon in the Elwha River
Chum Salmon	Possible direct fish loss caused by extreme sediment levels	Move adults/eggs out of lower river to nearby streams or hatcheries; establish brood run at tribe hatchery	Outplant eggs/juveniles into tributaries, side channels, and/or middle and upper Elwha River starting before dam removal	Reduce fish loss caused by high sediment levels; replace young fish lost to high sediment levels; begin to reestablish chum in the middle and upper Elwha River
Sockeye Salmon	No direct fish loss	No actions to develop brood; remove Lake Sutherland outlet screens and possibly restore passage via Indian Creek to regain sea access	No outplanting	No hatchery or outplanting effects; the existing Lake Sutherland kokanee population may eventually reestablish a native sockeye run
Steelhead	Possible direct fish loss caused by extreme sediment levels	Collect late run brood and raise juveniles	Outplant juveniles in upper Elwha River	Reduce fish loss caused by high sediment levels; replace young fish lost to high sediment levels; begin to reestablish steelhead in the middle and upper Elwha River
Searun Cutthroat Trout and Char	Possible direct fish loss caused by extreme sediment levels	No actions to protect or develop brood	No outplanting	No hatchery or outplanting effects; natural recolonization by remnant stocks would eventually reestablish anadromous populations

severe (see table 49), effectiveness of other restoration measures would be greater.

Vine maple leaves. (Curtis Miller photo)

Conclusion

The long-term beneficial impacts would be the same as the proposed action. The short-term adverse impacts of fine sediment on trout and salmon and their habitat would be reduced by removing as much as 75% of the fine sediments with a dredge and slurry pipeline in combination with other restoration actions. Direct fish losses and the risk of straying adults would also be reduced, and restoration time slightly reduced.

Vegetation

Summary of Regulations and Policies

National Park Service policies on the management of natural resources, including vegetative communities, are based on park management zoning. Natural resources in natural zones are to be managed for fundamental ecological processes. Management goals are to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and ecological integrity of plants and animals (NPS 1988a, 4:1). The policies also call for the restoration of natural aquatic habitats and the natural abundance and distributions of associated terrestrial habitats and species. Additionally, one of the primary goals in the overall mission statement of the Department of the Interior is to protect plant and animal biological diversity (biodiversity) on public lands.

Lands adjacent to Lake Mills and Glines Canyon Dam facilities are classed in a natural zone (NPS 1989). Lake Aldwell and surrounding lands are privately owned by the James River Corporation.

Olympic National Park has been recognized by the United Nations as a biosphere reserve — an internationally significant example of one of the world's biogeographic regions. With this recognition, the National Park Service is to pursue natural resource research, and is to use the reserve as a framework for local, regional, and international cooperation (NPS 1988a, 4:4). The overall management of a biosphere reserve demonstrates the value of conservation; it includes designation of a core natural area for the protection of natural ecosystems and biodiversity, and baseline ecological monitoring (Peine 1985). This protected core is then used for comparison to external, manipulated landscapes.

One of the purposes of the park, stated in a congressional report accompanying the park's 1938 enabling legislation, is to preserve the finest sample of primeval forests of Sitka spruce, western hemlock, Douglas-fir, and western red cedar in the entire United States (NPS 1989). The combination of abundant moisture and a cool though moderate climate provides ideal circumstances for coniferous trees. The first of the park's five primary management goals is to conserve, maintain, and restore, where possible, primary natural resources and those ecological relationships and processes that would prevail were it not for the advent of modern civilization (NPS 1989). Individual management objectives within this goal include the development of programs to reverse or mitigate adverse impacts from human actions, to revegetate areas affected by human impacts and to eliminate or control exotic plants that threaten native plant communities.

Methodologies for Analyzing Impacts

Vegetation was surveyed on uplands (FERC 1993) in the vicinity of the two reservoirs and, for comparison, in relatively pristine bottom land sites (see Affected Environment section). Wetland field identification and mapping were updated in 1995. Disturbance acreages, primarily areas near the damsites, and recovery acreages, primarily the lake beds, were calculated. Vegetation at other specific sites was examined through site visits.

Impacts of No Action

General Acreages

The dams and reservoirs occupy an area of approximately 715 acres. Of this total, 684 were inundated by the reservoirs, and 31 covered by the dams and facilities. It is estimated that most (514 acres) of the reservoir area was forested with conifers and hardwoods, 48 acres were vegetated wetlands (including 24 acres of forested wetland), 24 acres were grassland, and 122 acres were nonvegetated wetlands (river channel and gravel bars, see table 50 for listing by type). Of these acres, 534 acres were riparian communities and 150 were upland.

Riparian and Upland Communities

The reservoirs inundated more than 5 linear miles or an estimated 534 acres of riparian vegetation along the river. Riparian vegetation is a critical component of the overall hydrologic processes of the Elwha River; its loss is major and adverse. In general, a natural riparian zone connects montane headwaters with lowland terrains, providing avenues for the transfer of water, nutrients, sediment, organic matter, and aquatic and terrestrial organisms (Gregory et al. 1991) A natural riparian zone reduces the severity of flood events, acts as a buffer to pollution sources entering the river, controls the loss of groundwater nutrients into the river, and provides important fish habitat and food sources from overhanging vegetation and associated terrestrial insects. An additional 150 acres of upland communities also were lost.

Wetlands

Wetlands modulate river flows during storm events, stabilize banks and erosion, trap sediments, retain nutrients, provide wildlife habitat, and facilitate energy and nutrient flows (Brinson et al. 1981, Adamus and Stockwell 1983).

A total of 48 acres of vegetated wetlands were inundated by the reservoirs. An additional 122 acres of unvegetated wet river channel and gravel bars also were covered. These are considered major losses to the ecosystem.

In addition, the armoring of the river channel between the reservoirs and below Elwha Dam has reduced overflow areas and backwaters that create and maintain small riverside wetlands. The reservoir pools themselves may contribute to the maintenance of two existing, wetland areas on the shorelines (see Impacts of the Proposed Action).

Conclusion

A total of 562 acres of potential natural vegetation is inundated by the reservoirs and 31 acres unavailable due to the dams and associated project facilities. This includes more than 5 linear miles of low elevation riparian communities and natural wetlands. Selection of the No Action alternative would continue these major impacts.

Impacts of the Proposed Action – River Erosion Alternative

General Acreages

The largest impact would be the permanent beneficial recovery of approximately 562 acres of forest and other vegetation in the reservoir beds. The goal of revegetation is, over the long term, to reestablish the forest community that would have existed in the absence of human influence. To facilitate recovery, a revegetation plan to replant native riparian and upland vegetation within the reservoir areas and along approximately three miles of restored power line corridors would be implemented. The former reservoirs would be revegetated to provide for erosion control while replicating representative vegetation community types, species composition, plant

Elwha River, no date. (Clallam County Historical Society)

Table 50. *Expected Vegetation Types in Recovered Reservoir Areas*

VEGETATION TYPE	ACRES RECOVERED
Upland	
Conifer Forest	150
Riparian	
Conifer Forest	268
Mixed Forest	20
Hardwood Forest	52
Palustrine Forest (wetland)	24
Palustrine Shrub (wetland)	24
Grassland	24
Total Vegetated	**562**
River/Stream (wetland)	57
Cobble/Gravel (wetland)	65
Total Unvegetated	**122**
TOTAL RESERVOIR AREA	**684**

SOURCE: FERC 1993

density, spacing, and overall structure. Terrace side slopes may be allowed to stabilize prior to planting. The active river channel would be allowed to revegetate naturally by wind- and waterborne seed and natural rooting of woody debris. Invasive nonnative species would be controlled or eradicated where possible (see appendix 3).

Riparian and Upland Communities

Most of the 562 revegetated acres (approximately 514) are expected to be forest stands (see table 50); however, up to 90 native plant species may eventually enter the area (NPS 1994a). Based on existing conditions in Krause Bottom, it is expected that 73% of the 562 acres revegetated (412 acres) and all 122 acres of unvegetated recovered area would be riparian bottom land or wetlands, while 27% (150 acres) would be upland communities. Removal of dams, powerhouse, transmission lines, and roads, and their subsequent revegetation, would total 31 acres of additional recovered vegetation. Some areas will not revegetate, such as the canyon-walled damsites, and would remain as bare rock, talus field, or moss and lichen-covered rock.

Full vegetative recovery would be long-term, taking at least 100 years to approximate pre-dam conditions. However, within three years, vegetation would begin to appear natural, and be stabilized enough to mimic pre-dam levels of erosion within six to ten years. Large amounts of coarse sediments are likely to remain in numerous small terraces at the southern end of Lake

Mills. Therefore, site topography in this area would not return to, but would approximate, pre-dam conditions. With over 70 species of nonnative plants in the area, some recovering sites might become dominated by nonnative species unless aggressive control activities were maintained (NPS 1994a).

Of the 534 acres returning to riparian or wetlands, approximately 412 acres of the area now inundated by the reservoirs would be vegetated. Given the scarcity of protected low elevation forest communities on the peninsula (see Cumulative Impacts below), protection of more than 400 acres of riparian vegetation would be a major beneficial impact in the protection of the region's biodiversity.

A small stand of trees at Glines Canyon Dam would have to be removed to install and operate a large crane necessary for deconstruction. Sediment deposition in the middle, lower, and delta reaches of the river would change the flow of floodwaters. Small, localized areas of vegetation are likely to die from changes in flooding. The river would probably abandon other channels which would then revegetate. The river delta would become particularly dynamic, with the river mouth periodically moving into once-abandoned overflow channels.

Removal of small patches of vegetation would be required to install water quality protection facilities, including a new Ranney well, infiltration gallery, and groundwater wells. Improving Olympic Hot Springs Road for heavy equipment would require removing small amounts of natural forest vegetation within the park. Vegetation at the concrete disposal sites (pending final site selection) may be buried or removed, if any exists. Minimal vegetation would be disturbed from the raising of the flood control levee since vegetation is already routinely cleared for maintenance.

Wetlands

A portion of the 43 acres of existing wetlands would be eliminated or degraded with the draining of the reservoirs, while an estimated 48 acres of palustrine forest, or palustrine shrub wetlands would naturally establish along the river (FERC 1993). Emergent wetlands could form in a few years, while forest and shrub wetlands would take from 10 to 20 years. All of these types would form in abandoned channels, backwaters, and oxbows once the majority of the sediment load is flushed to the sea and river dynamics are relatively stabilized. An additional 122 acres of wet channel/river and gravel bar wetlands would be created with the return of a natural river in the reservoir beds. During revegetation of the lake beds, placement of woody debris may be used to stimulate the development of small wetlands.

Of the 43 wetland acres near lake shores that the FERC report assumed would be lost, 38 are located at the upstream end of Lake Aldwell. Examination of US Geological Survey substrate compositions and of habitat maps reveals that the majority of these 38 acres are not on the delta and therefore would not be lost by draining of the reservoir nor by erosion of delta sediments. Some reduction in the size of this wetland may occur if the water table drops following the draining of the reservoir, but the close proximity of the river and of Indian Creek is expected to moderate a change in the water table. Additionally, a 5-acre wetland near the boat launch on Lake Mills is probably maintained by upslope seepage and is not expected to be affected by reservoir draining.

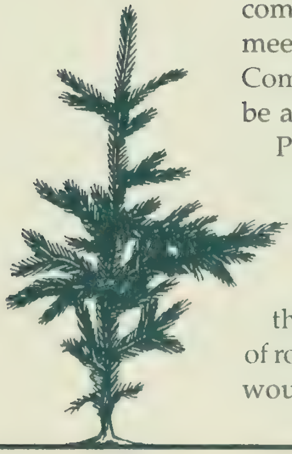
Cumulative Impacts

Filling of the reservoirs destroyed more than 5 linear miles of low elevation (less than 600 feet) riparian and wetland communities. Many other low elevation riparian communities on the Olympic Peninsula have been impacted through the removal of natural forest vegetation. Most areas are in various stages of forest regrowth, but remain in active logging rotations. With the exception of portions of some west side rivers, no low elevation riparian areas on the peninsula are managed for natural conditions and long-term protection. Recovered river bottom lands in Lake Mills and Lake Aldwell would be managed for long-term protection.

On a national scale, losses of riparian communities have been severe. It is estimated that one half of the riparian and wetland zones of the contiguous United States has been destroyed, while documented losses in many western states have been extreme (Lamb and Lord 1992, Rieger 1992). Impacts on riparian areas on western lands administered by other federal agencies are widespread and major, while impacts on those in private holdings, such as in California's Central Valley, are even more severe. With riparian areas comprising less than 1% of the western United States (Douglas et al. 1992), these conditions are particularly alarming considering the critical role that riparian communities play in the maintenance and protection of biodiversity (see the Affected Environment section). Vegetative recovery of the riparian zone under this alternative would, on a local scale, improve these trends.

Conclusion

Revegetation of 562 acres of reservoirs and up to 31 acres of land now occupied by the dams and associated facilities to natural plant communities, and return of 122 acres of unvegetated wetland areas, would help maintain all the components and processes of naturally evolving ecosystems, and would help meet biosphere reserve goals as well as Olympic National Park objectives. Compliance with these national and international goals and objectives would be a major beneficial impact locally, regionally, and, based on the National Park Service mission, nationally.



Impacts of the Dredge and Slurry Alternative

Impacts would be the same as impacts from the Proposed Action with the following differences. If the slurry pipeline were routed down the edges of road beds, some impacts to vegetation may occur; however, this disturbance would probably be within the road corridor that is routinely cleared of vegetation during maintenance. All impacts, if any, would be in previously disturbed areas. Similarly, if routed down the flood control levee, minimal vegetation would be disturbed since the levee is routinely cleared of vegetation. Some impacts may occur while constructing the pipeline along the edge of the river, although the alignment would be on the largely unvegetated, immediate river edge. Some minor differences in the species makeup of the plant community colonizing the reservoir beds would be expected in response to the lesser amount of fine sediments remaining under this alternative.

Conclusion

The recovery of 562 acres of natural vegetative communities, and return of 122 acres of unvegetated wetland areas, including the components and processes of the naturally evolving ecosystem, would be a major beneficial impact locally, regionally, and, based on the National Park Service mission, nationally.

Wildlife

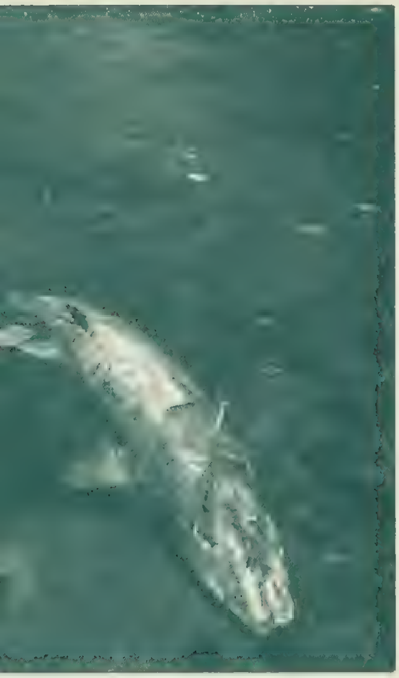
Summary of Regulations and Policies

General National Park Service management policies for wildlife include those listed under vegetation. In addition, wildlife management should minimize human impacts on natural wildlife population dynamics, while protecting native wildlife populations against harvest, removal, destruction, harassment, or harm through human action (NPS 1988a 4:5).

One of the purposes of the park, stated in a congressional report accompanying the park's 1938 enabling legislation, is to provide suitable winter range and permanent protection for herds of native Roosevelt elk and other native wildlife species (NPS 1989). The park's distinctive fauna has been identified as one of its primary resources.

Methodologies for Analyzing Impacts

The US Fish and Wildlife Service's Habitat Evaluation Procedure was used to estimate habitat lost by reservoir inundation, and to estimate habitats that would be recovered in the lake beds after revegetation. The Habitat Evaluation Procedure combines habitat quality and habitat quantity parameters into a single value called a Habitat Unit. Habitat quality is expressed as a value from 0 (no value) to 1.0 (optimal value). The habitat quality spectrum is unique for each species of wildlife, based on its biology and life history requirements, and has been researched and standardized by the Fish and Wildlife Service. In this simple model, habitat units are then determined by multiplying an area's value by the acreage of the area. Nine



Decaying fish carcass adds phosphorus and nitrogen to the river's ecosystem. (Natalie Fobes photo)

representative species were selected to estimate the habitat originally lost with reservoir inundation. A survey for amphibian species was also completed in the summer of 1995.

Impacts of No Action

The primary impacts to wildlife have been the loss of habitat and anadromous fish populations that had occupied the river year-round. The reservoirs inundate 684 acres of land; the dams and associated facilities occupy an additional 31. The 5.3 miles of river lost was optimal habitat for raccoon, muskrat, river otter, beaver, and mink. Use of important riparian, aquatic, and wetland habitat was lost when this section was inundated.

Roosevelt elk, which require low elevation forested and riparian bottom lands for winter habitat and grazing, have suffered adverse impacts from the inundation of habitat. Deer, mink, beaver, Douglas squirrel, Cooper's hawk, pileated woodpecker, and yellow warbler, used as representative species for the area, have been impacted by the loss of habitat.

In the upper and middle Elwha, populations of fish-eating wildlife species may have decreased when salmon and trout were blocked by dam construction. At least 22 wildlife species that use salmon as food, including black bear, mink, mountain lion, bobcat, and river otter, could have been adversely affected by the dams (Cederholm et al. 1989).

Some species benefitted from the dams and reservoirs. The common goldeneye, bufflehead, and lesser scaup are common winter residents on both reservoirs. Trumpeter swans also use Lake Aldwell as winter habitat.

Conclusion

A total of 715 acres of natural wildlife habitat would remain unavailable. Without anadromous fish runs — a critical component of the wildlife community — natural biodiversity of the area would remain compromised. The loss or severe depletion of anadromous fish runs would continue to adversely affect 22 wildlife species. Important riparian habitat would continue to be unavailable for use by winter elk and several other species.

Impacts of the Proposed Action – River Erosion Alternative

Restoration of native anadromous fish runs and the subsequent availability of salmon as prey in the middle and upper Elwha would benefit at least 22 wildlife species known to use this food source (Cederholm et al. 1989). Total biomass from returning salmon would increase about 12 times over existing conditions (FERC 1993) or by 800,000 pounds per year. Decaying carcasses would also add about 13,000 pounds of phosphorus and nitrogen to the river annually. These kinds of interactions between anadromous fish and terrestrial wildlife communities are a central component of ecosystem function, and therefore, of the maintenance of regional biodiversity (Willson 1995). Returning salmon as prey would have a major beneficial impact on the majority of wildlife in the Elwha River corridor.

Impacts to most wildlife species would be permanent and beneficial (See Impacts section, Species of Special Concern for more information). Habitat Evaluation Procedure models for the representative species — elk, deer, mink, beaver, Douglas squirrel, Cooper's hawk, lesser scaup, pileated woodpecker, and yellow warbler — were completed to measure changes in habitat for each of these species (FERC 1993). In the long term, after the reservoirs are drained and revegetated, all nine species except the lesser scaup would have net increases in available habitat. Increases vary from a minor 4 habitat units for the yellow warbler to 306 habitat units for the pileated woodpecker.

Species that prefer lake habitat, such as scaups and some other waterfowl, would be adversely affected, while species that prefer river, riparian, and upland habitats would be beneficially affected. If lands are managed by the tribe and timber is harvested on uplands around Lake Aldwell, other species of wildlife would be affected by loss of habitat and human activity associated with development.

The lesser scaup is a diving duck that uses some of the deeper, still nearshore waters of the existing reservoirs, but would use river habitat only marginally. These birds would have to move to nearby lakes or sheltered marine waters. Some habitat for lesser scaups would be created at the river mouth depending on how large an estuary is formed. Since scaups are one of the most common wintering ducks in the Puget Sound area (WDFW 1994b), habitat loss would be inconsequential.

Draining and revegetating the reservoirs would create more elk habitat, including important bottom land riparian areas. It also would extend the elk migration corridor connecting high elevation subalpine parklands with low elevation forests farther down the Elwha valley. Since quality elk winter habitat is limited, and winter habitat outside the park is continually being impacted, restoration and protection of low elevation forested bottom land would be a major beneficial impact for the elk population.

Trumpeter swans currently use both reservoirs (see Affected Environment section) although reservoir habitat is limited. Since a swan dips its head and neck into the water to feed on bottom vegetation, aquatic foraging habitat is limited to the shallow upstream end of the reservoirs. Trumpeter swans, being about 4 feet long, can utilize only waters to a maximum depth of 4 feet. At full pool, Lake Aldwell contains approximately 52 acres of waters less than 4 feet deep (June 9, 1995, letter from Richard A. Link, Bureau of Reclamation to Jeff Bohman, Lower Elwha Klallam Tribe). Lake Mills contains approximately 51 such acres, although this habitat is used much less than that at Aldwell. Based on actual aquatic vegetation in the areas, these figures were refined by Jordan (1995) who found approximately 20 acres of foraging habitat at Lake Aldwell and an estimated 3 acres at Lake Mills. This habitat would be lost and swans would move to other wintering sites. Also, some swan habitat would be naturally created at the river mouth, again depending on how large an estuary is formed. The impact to this local population of swans would be moderate, but to the Pacific coast population it would be minor. Acquisition of protective easements at other known wintering sites and monitoring could further reduce impacts.

Species that would lose river habitat through increased turbidity during the construction period, but gain habitat and an increased abundance of prey in the long term, include belted kingfisher, great blue heron, otter, mink, and fish-eating waterfowl such as mergansers. Most species of amphibians would be beneficially affected through a net increase in wetland and river-edge habitats.

Recovery of riparian and upland wildlife habitat would be a major beneficial impact to most species modeled.

Cumulative Impacts

Based on habitat modeling, existing elk winter forage in the project vicinity is limited, and habitat quality is low (FERC 1993). Subpopulations are considered vulnerable due to their low numbers and to increasing development on winter range adjoining the national park. In the reservoir areas, short-term recovery of grazing habitat and long-term recovery of mature forest stands for thermal cover (an essential component of winter habitat) would benefit the local elk subpopulation. Various wildlife species in the vicinity of the northern park boundary are being increasingly impacted through the conversion of land use from natural conditions to human activities. This has the effect of isolating populations and minimizing diversity. The revegetation and long-term protective management of lands at Lake Mills in Olympic National Park and river corridor lands through Lake Aldwell would reverse this by recreating a connecting corridor that would benefit many wildlife species.

Conclusion

Recovery of riparian and upland wildlife habitat would be a major beneficial impact to most species modeled. Although species dependent on the reservoirs would lose habitat, many more species that feed upon salmon would sustain a major beneficial impact from their return.

Impacts of the Dredge and Slurry Alternative

Impacts would be the same as the proposed action except that temporary impacts to resident wildlife species would occur from constructing the pipeline along the river's edge. Numerous species including mink, river otter, osprey, and mergansers would be temporarily disturbed during construction, maintenance, and deconstruction of the pipeline. Depending on the timing of construction, osprey nesting below Elwha Dam might not be successful.

However, only an estimated 1.2 to 1.4 million cubic yards of fine sediments would be transported by the river, reducing the amount and duration of turbidity in the river. While the pipeline was in use, fish and invertebrate eating species would not be impacted as greatly as under the proposed action.

Conclusion

Recovery of riparian and upland wildlife habitat would be a major beneficial impact to most species modeled. Although species dependent on the reservoirs would lose habitat, many more species that feed upon salmon would sustain a major beneficial impact from their return.

Species of Special Concern

Summary of Regulations and Policies

The national mandate of the Endangered Species Act states that fish, wildlife, and plant species are of aesthetic, ecological, educational, historical, recreational, and scientific value to the nation and its people. The act's purpose is to conserve the ecosystems upon which species depend and, generally, to increase populations and secure sufficient habitat to recover species to viable levels.

The act requires the National Park Service to determine whether a proposed action would affect federally listed threatened or endangered species. Consultation with the US Fish and Wildlife Service is required if the action may affect such a species to ensure that it does not jeopardize the species' continued existence.

Management Policies (NPS 1988a) require the National Park Service to identify and promote the conservation of all federally listed threatened, endangered, or candidate species within park boundaries (4:11). The National Park Service also would control access to critical habitats and conduct management programs that perpetuate the natural distribution and abundance of these species and the ecosystems on which they depend. The policies further require consideration of all state and locally listed species in planning activities. Management objectives specific to the park include the reestablishment of species that have been eliminated as a result of human activities (NPS 1989).

Methodologies for Analyzing Impacts

Documents relevant to species of special concern were reviewed for baseline information; biological, life history requirements, and numerous field surveys were completed (see the Affected Environment section and sections on individual species below).

Impact analyses are based on a number of factors: the known or likely occurrence of a species or its preferred habitat in the vicinity of the dams, dam facilities, reservoirs, the river corridor, or the marine environment; direct physical loss of habitat or the effective loss of habitat (through avoidance or abandonment) due to construction activity or noise, or due to sediment management and transport; and the species' sensitivity to human disturbance. The ability to predict impacts using these tools is limited to qualitative assessments by team biologists.

Impacts of No Action

Federally Listed Species

Bald Eagle. Both wintering and nesting eagles were affected by the loss of salmonids as prey. On the middle and lower reaches of the river, the number of eagles feeding on spawning salmonids or carcasses probably decreased during the nine months when carcasses had traditionally been available (August through April). With fewer large riparian trees dying due to reduced meander, the number of snags has decreased that eagles could use as nesting, foraging, and roosting sites has decreased.

Northern Spotted Owl. A total of 514 potential acres of mature and old-growth forest habitat was inundated by the reservoirs, eliminating potential nesting, roosting, and foraging habitat for spotted owls.

Marbled Murrelet. A total of 438 potential acres of old-growth conifer and mixed forest habitat was inundated by the reservoirs, eliminating potential nesting habitat for murrelets.

Steller Sea Lion. Since salmon constitute only a small percentage of the Steller Sea Lion's diet, the reduction in Elwha salmonids due to the dams would have had only a minor impact on this species.

Peregrine Falcon. The decline of the estuary brought about by the reduction in sediment transported to the river mouth may have reduced winter prey for this species.

Federal Candidate Species

Pacific Fisher. Fishers prefer riparian areas in winter as well as in summer (DOI 1992), and are one of 22 species of wildlife in the area that feed on salmon. The dams had and continue to have adverse impacts on this species both through the inundation of habitat and loss of salmonids as prey.

Harlequin Duck. Harlequins nest in riparian areas and forage in flowing waters. A total of 5.3 miles of natural riparian and river habitat was lost when the dams were built.

Northern Goshawk. This alternative would not impact goshawks.

Northern Red-Legged Frog. This species is associated with woodlands along streams. Removal of 5.3 miles of riparian habitat and wetlands associated with added river meanders probably reduced the total habitat available for this frog.

Bull Trout. The dams degraded habitat and cut off access to the sea for bull trout or native char (See Fisheries section above).

Wildlife Species with State Status

Van Dyke's Salamander. The adverse impact on this seepage and stream-associated salamander is largely unknown but may have been major with removal of over 5 river-miles of riparian habitat in the project area.

Vaux's Swift. A potential 514 acres of forested nesting habitat was inundated by the reservoirs when the dams were built.

Pileated Woodpecker. A potential 514 acres of forested nesting and foraging habitat for this species was lost when the dams were built. Pileated woodpeckers use trees for cavity nests, and several species use abandoned cavities when the woodpeckers leave them. The woodpeckers also prefer older forests, snags, downed logs, and stumps, which would have been inundated by the reservoirs.

Golden Eagle. This alternative would not impact golden eagles.

Common Loon. Loons have benefitted from the dams, as they use the reservoirs occasionally to forage.

State Sensitive Plant Species

Tall bugbane (*Cimicifuga elata*), branching montia (*Montia diffusa*), giant helleborine (*Epipactis gigantea*), California hedge-parsley (*Yabea microcarpa*). Hedge-parsley, helleborine, and bugbane may have been impacted in the past by road building and dam construction. No changes to the populations of these species would occur.

Other Rare Species

Chum, and chinook salmon, steelhead and searun cutthroat trout (which are all under status review), and coho salmon (proposed as a candidate by the National Marine Fisheries Service) are directly affected by the loss of historically available spawning and rearing habitat.

Conclusion

Most species of special concern have been and would continue to be adversely affected by the presence of the dams, either because habitat is inundated or occupied by the projects, or salmon prey species no longer are available.

Impacts of the Proposed Action – River Erosion Alternative

Federally Listed Species

Bald Eagle. In the short term, the proposed action could affect bald eagles by impacting their prey resources. Glaucous-winged gulls and marine fish are important prey species for eaglews along the coast. With increases in marine water turbidity, the numbers of gulls foraging in the vicinity of the river mouth and marine fish in the turbidity plume may decrease. Increased turbidity and its effect on gulls and marine fish would be expected to last approximately two years. If the supply of gulls and fish decreases as a result of higher turbidity, the reproductive success of the two local eagle nests could be reduced in the short term. Eagles, however, are opportunistic feeders, and nesting birds probably would travel farther east or west along the shore temporarily.

In the long term, both wintering and nesting eagles would likely benefit from the restoration of salmon runs. On the middle and lower reaches of the river, the number of eagles feeding on spawning salmonids or carcasses would probably increase in all months except May, June, and July when no stocks are spawning, as eagles prefer carcasses to catching live fish. The more dynamic river channel expected after recovery would create snags, or large dead trees, important as perch and roost sites. A more braided river with gravel bars, which retain spawned salmon, would provide improved foraging habitat (USFWS 1986). An additional 5.3 miles of riverine habitat would be available for fish prey species.

In the long term, both wintering and nesting eagles would likely benefit from the restoration of salmon runs.

Nesting birds in existing territories would probably continue to forage along the river, while additional territories may be established along the river itself. The Pacific Bald Eagle Recovery Plan (USFWS 1986) targets 12 additional recovery territories for the park and portions of the national forest. Recovery of anadromous fisheries may contribute to the recovery of these nesting territories.

Northern Spotted Owl. Based on nesting surveys between 1990 and 1995, four nest sites or activity areas are in the vicinity of the dams and reservoirs. The closest nests to Glines Canyon and Elwha dams are almost 1, and 1-1/4 miles, respectively. The proposed action would be expected to have only minor impacts on spotted owls because of the distances between nest sites and the dams, the conservation measures being proposed (i.e., delayed blasting, use of a diamond-wire concrete saw, and limitation on helicopter flights), and because the project does not involve the removal of a significant quantity of suitable habitat. Construction impacts would last no longer than two years. Construction, with these conservation measures, would not be expected to adversely affect spotted owls.

Over the long term, the lake beds would return to mature and old-growth forest stands, creating additional nesting, roosting, and foraging habitat for spotted owls. Forest stands mature enough for use by spotted owls would take at least several decades to establish. The newly forested lake bed in the national park would be protected in perpetuity. All potential managers of Lake Aldwell lands have indicated that at least some of their forested acreage would be protected. An estimated 514 acres of conifer, mixed, deciduous, and palustrine forest habitat at both sites eventually would be available for foraging, roosting, and possibly nesting.

Marbled Murrelet. In the short term, murrelets might be adversely affected in three areas — while foraging in marine waters, while flying upriver to nest sites, and possibly at nest sites. Increased turbidity in marine waters would probably displace feeding murrelets. Displacement might be local, with foraging birds moving a short distance, and would depend on tide and currents since the river's sediment plume sometimes tracks northeast and sometimes northwest (Schwartz 1994).

During nesting and fledgling periods, murrelets feed more on small fish rather than on the invertebrates which constitute their primary diet at other times (USFS 1995). Highly turbid marine waters may be avoided by fish prey species, and prey and murrelets may simply move to clearer waters. Farther west and east, from Crescent Bay to Ediz Hook, much larger numbers of murrelets were observed in surveys. Although concentration of sediment during dam removal would be lower in these areas than at the river mouth, these birds, too, could be temporarily affected by increases in turbidity.

Construction activity could adversely affect murrelets as they fly between the coast and their nest sites. Although murrelets primarily follow the river on these daily forays, it is expected that localized activity at either damsite would simply be avoided and would not interrupt movement patterns. If nesting birds and fledglings were in the vicinity of the dams, they might be adversely impacted from construction noise and activity. However, marbled murrelet surveys conducted in 1990 and 1995 did not uncover any nesting murrelets in the vicinity of either dam. The surveys indicated low numbers of birds traveling through the project area but no evidence of nesting in the vicinity of either dam, Lake Mills, Lake Aldwell, or associated access roads. Murrelet surveys are planned for 1996 to comply with US Fish and Wildlife Service survey protocol which requires two consecutive years of survey to assess murrelet presence at a particular location.

Construction activity and increased sediment in marine waters, even with conservation measures, have the potential to adversely affect marbled murrelets in the short term. The degree of impact and effectiveness of mitigation would be part of a biological assessment required by the US Fish and Wildlife Service under the Endangered Species Act.

If 1996 surveys show birds close enough to be affected as they fly to inland nest sites, construction activities would be restricted. These measures are mandatory and could include noise reduction, use of specialized equipment, and changes to the sequencing/timing of activities. Delayed blasting and the use of a diamond-wire concrete saw are two measures being proposed to reduce noise impacts on marbled murrelets. With delayed blasting, noise level is reduced because individual charges are detonated in sequence instead of concurrently. Noise also would be reduced by the use of the diamond-wire saw in lieu of blasting. If marbled murrelet nesting is determined by the 1996 surveys, the set of mitigating measures required by the Fish and Wildlife Service in its biological opinion would probably include restrictions on blasting, crane and jackhammer operations, and concrete loading timed to avoid the periods of greatest flight activity during the nesting season — the two hours before sunrise and the two hours after sunset between April 1 and September 15.

The biological assessment and subsequent biological opinion, required under formal consultation with the US Fish and Wildlife Service, will be completed after the draft environmental impact statement. Construction impacts would not last longer than two years.

Above river mile 16 (the upper end of Lake Mills), eggs and juvenile salmonids would be outplanted by helicopter starting the year before deconstruction begins. Numerous helicopter flights are anticipated over at least the following 10 years (see appendix 2). Helicopter flights over suitable habitat have the potential to adversely impact the murrelet. Conservation measures expected to be imposed by the US Fish and Wildlife Service include minimizing hovering over suitable nesting habitat, maintaining a height of at least 100-feet above the forest canopy over suitable habitat, and flying at a speed of at least 25 knots between drop sites to reduce downdraft.

Over the long term, the lake beds would return to old-growth forest stands, creating additional nesting habitat for murrelets. It would probably be 80 to 100 years before the sites were suitable as nesting habitat since nesting murrelets in western Washington appear to select for sites with dominant trees of at least 20- to 30-inch diameter at breast height with multiple canopy layers (USFS 1995). Approximately 438 acres of conifer and mixed forest habitat would eventually be available (see Impacts to Vegetation).

Possible impacts to proposed critical habitat for murrelets on US Forest Service and state lands would be minimal. Restored natural river dynamics may flood and perhaps kill some vegetation along the short reaches of river within these areas.

In the short term, the proposed action could have minor to moderate impacts on the marbled murrelet because of impacts to its food supply in Freshwater Bay and disturbance from construction activity and helicopter flights upstream of Lake Mills. In the long term, this species would sustain a major beneficial impact from the increase in nesting habitat and the additional prey resources resulting from the restoration of the anadromous fish runs and the river's estuary.

Steller Sea Lion. Although salmon constitute only a small percentage of their diet, in the long term Steller sea lions would benefit from restored populations of salmonid fish. In the short term, sea lions may avoid foraging in the vicinity of the mouth of the river due to high turbidity levels.

Peregrine Falcon. Nesting peregrines would not be impacted by the proposed action. Wintering birds, concentrating in the Sequim area 20 miles away, may occasionally hunt in the coastal area near the mouth of the river. If this occurs, impacts would be minimal since peregrines are wide-ranging birds, particularly in the nonbreeding season, and hunt a wide variety of bird prey species, few of which would be impacted. In the long term, with the development of a more natural estuary, habitat for winter prey species would increase.

Federal Candidate Species

Pacific Fisher. Fishers prefer riparian areas in winter as well as in summer (DOI 1992). General habitat management recommendations include the maintenance of contiguous forest canopies in riparian areas, retention of snags and downed logs, and the protection of wetlands (WDW 1991). Restoration of 5.3 miles of riparian river areas as well as the protection of associated wetlands and a natural abundance of downed logs would all benefit this species.

Harlequin Duck. Since harlequins nest in riparian areas and forage in flowing waters these ducks would benefit from the recovery of 5.3 miles of riverine and riparian habitat. However, harlequins are highly sensitive to any kind of human disturbance and are unlikely to re-nest if disturbed (WDW 1991). Studies in North Cascades National Park indicate that harlequins are even more disturbed by humans on foot than in rafts or kayaks (NPS 1990). If recreational use of the river increases following ecosystem restoration, particularly fishing and hiking near the shore, some of this habitat gain would be effectively lost through disturbance and abandonment of nesting or foraging sites. If any new trails are constructed, they should be located at least 165 feet from the edge of streams (WDW 1991).

The only new trail proposed for the Lake Mills lake bed is between Cat Creek and Boulder Creek, and camping would be permitted on the river's gravel bars in this section. Depending on the trail location, harlequins may not use at least the trailed side of the river in this area. The West Lake Mills trail would remain on the present lake shoreline, well removed from the new river channel.

The two known nesting sites on the river between the lakes would probably not be successful in the short term, during the years of heaviest turbidity in the river. Harlequins foraging in river waters may not be able to locate invertebrate prey. Also, like murrelets, wintering harlequins would be displaced from marine waters near the river mouth due to high turbidity levels.

Northern Goshawk. One pair is known to traditionally nest along the Whiskey Bend trail. The nest site, however, is approximately 3 miles up the trail from the upstream end of Lake Mills and would not be expected to be impacted by the Proposed Action.

Northern Red-Legged Frog. This species would probably benefit from dam removal over the long term due to the increase in riparian habitat. The effect of short-term disturbances from dam removal activity is largely unknown; river turbidity may temporarily lower egg survival and food availability at some locations and decrease frog abundance.

Bull Trout. The primary short-term impact to bull trout caused by removing both dams is increased downstream sedimentation and turbidity (see Impacts on Fisheries section). For one and one-half to four years, there would be periods

when suspended sediment levels in the middle and lower river and in the two lakes would be lethal to bull trout. Bull trout in Lake Mills could escape the highly turbid water during reservoir drawdown by moving upstream. River habitat in these reaches would be covered with fine sediments and be unsuitable for spawning, rearing, and feeding during this time. Habitat conditions would begin to improve to pre-dam conditions after the second year. Bull trout from the upper river and tributaries would naturally begin to recolonize the lower 16 miles of the river as habitat conditions improved.

The long-term benefit of the proposal would be the restoration of bull trout to their historic fluvial or anadromous life history patterns, as well as the restoration of their anadromous fish prey base. The removal of the two reservoirs, however, would result in the permanent loss of lake habitat currently used by the trout. The restoration potential for anadromous bull trout (referred to as "native char" along with Dolly Varden trout in this environmental impact statement) is considered good. The proposed action would result in accessible and improved river habitat with restored spawning gravels, increased nutrients, increased woody debris cover, and normal water temperatures.

The proposed action would result in major, permanent benefits to bull trout. Restoration of its anadromous life history form, its prey base, and improvements in water temperature, substrate, and woody debris availability in the middle and lower river would more than offset the loss of lake habitat.

Wildlife Species with State Status

Van Dyke's Salamander. No evidence of this species was found in reconnaissance-level surveys in the project area in 1995, although it may occur there (Loafman et al. 1995). An increase in riparian habitat following dam removal would probably benefit this salamander over the long term.

Vaux's Swift. Foraging habitat for this species is not restrictive; it includes forests, clearings, lakes, and streams, and the proposed action would result in no net change. Nesting habitat, however, is restricted to large snags, and revegetation of the reservoirs would eventually result in approximately 514 acres of recovered forested lands, including natural abundances of snags (see table 50). These swifts would be beneficially affected.

Pileated Woodpecker. Preferring forests that are at least 40 years old, this species would be beneficially affected in the long term after forests recover in the lake beds (WDW 1991). Nesting and feeding habitat is primarily snags, downed logs, and stumps; natural abundances of these in the expected 514 acres of recovered forested lands would be beneficial (see table 50). Numerous other species in the ecosystem that use abandoned pileated nest cavities (see Affected Environment section) would benefit.

Golden Eagle. These eagles only occasionally visit the project vicinity and are not expected to be impacted by the proposed action. No impacts to nesting would occur.

Common Loon. The reservoirs are occasionally used for foraging by loons, and this habitat would be lost. Loons do not breed here and are in the vicinity primarily in the winter when small but widespread numbers are hunting in the marine waters of Puget Sound and the Strait of Juan de Fuca (WDFW 1994b). Loss of any reservoir use would be inconsequential. During dam removal, marine waters near the mouth of the river would have high turbidity and foraging loons in this area may be forced to move to less turbid waters to the east or west.

State Sensitive Plant Species

Tall bugbane (*Cimicifuga elata*). Roadside maintenance activities and subsequent erosion from increased use of the Whiskey Bend Road may impact this species.

Branching montia (*Montia diffusa*). Possible impacts on this species are unknown.

Giant helleborine (*Epipactis gigantea*). Road maintenance activity on Whiskey Bend Road could impact this species.

California hedge-parsley (*Yabea microcarpa*). Populations near Glines Canyon Dam could be impacted from trampling during dam removal.

All sites containing any of these sensitive plant species would be identified and protected from impacts during dam removal. Exact locations of the populations would be kept confidential and the sites monitored.

Other Rare Species

Other rare fish species and stocks would be adversely impacted in the short term from dam removal. Over the long term, dam removal and river restoration would offset some cumulative impacts to these species and stocks that occur elsewhere on the Olympic Peninsula and in the region. Causes of cumulative impacts that have lowered populations of these species and stocks to critical levels are not certain but include sedimentation, overharvesting, and water pollution.

Cumulative Impacts

Spotted owls and marbled murrelets have been impacted primarily through the logging of old-growth and mature forest communities. The consequence of continued logging activity in their habitat is currently an issue of local, regional, and national debate (USFS and BLM 1994). Bald eagle populations, recovered from their lowest levels in the 1970s, have been upgraded from endangered to threatened species status. Restoration of the salmonid fisheries in the Elwha River would support this trend.

Conclusion

The following species would be adversely impacted in the short term, most of them by turbidity or increased noise during the two year construction period: bald eagle, northern spotted owl, marbled murrelet, harlequin duck, and bull trout. The degree of impact to all but the marbled murrelet would be minor. Additional surveys necessary to comply with the Endangered Species Act and any appropriate mitigation would determine the degree of impact and appropriate mitigation for murrelets.

The bald eagle, northern spotted owl, marbled murrelet, pacific fisher, bull trout, Vaux's swift, and pileated woodpecker would sustain major, permanent benefits from dam removal. Long-term recovery of habitat for these listed species would be important on a regional scale, and would incrementally contribute towards the species' recovery throughout their ranges. This would be a major beneficial impact from the proposed action.

Impacts of the Dredge and Slurry Alternative

Impacts would be the same as those under the proposed action except for the following differences listed by species.

Federally Listed Species

Bald Eagle. Impacts would be similar but slightly less than the proposed action because the pipeline outfall would allow a large portion of the silt and clay to be discharged farther from shore and away from the mouth of the river. However, significant quantities of silt and clay would still be washed down the river, resulting in nearshore turbidity and potential impacts to eagle prey species.

Northern Spotted Owl. The only impact to owls different from those in the Proposed Action would be the dredging operation on Lake Mills. Electric generators and the dredges would operate 24 hours a day during use of the slurry pipeline. Generators would be either on the lake shore or on the floating barge. Noise from the generators would be expected to be audible for long distances; however, based on distance to nest sites, it would not be expected to impact nesting in the vicinity.

Marbled Murrelet. The generators necessary to operate the dredge in Lake Mills are the main additional concern for murrelets, as for spotted owls, when compared to the proposed action. Noise from the generators and dredge may adversely affect any nearby nesting murrelets. Nesting surveys are planned for 1996. Conservation measures might be required if subsequent surveys indicate nesting murrelets within the impact zone.

Federal Candidate Species

Harlequin Duck. Depending on timing, the construction and deconstruction of the pipeline along the river edge would impact nesting and foraging harlequins. Since they are particularly sensitive to disturbance during nesting, it is likely that nesting birds would abandon the nest and reproduction would not be successful for up to two years. While the pipeline was in use, however, turbidity levels would be greatly reduced compared to those under the proposed action, and harlequins might still be able to forage in the river.

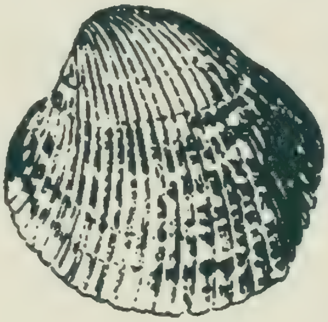
Bull Trout. Impacts would be very similar to those under the proposed action. Although river turbidity levels from fine sediments would be less, short-term impacts would remain lethal. Long-term impacts would be beneficial and permanent.

Other Rare Species

Impacts to the other rare fish species and stocks would be very similar to those under the proposed action. Although river turbidity levels from fine sediments would be less, short-term impacts would remain lethal. Long-term impacts would be beneficial and permanent.

Conclusion

Although some species would be adversely impacted in the short term (i.e. during the two year construction period), the bald eagle, northern spotted owl, marbled murrelet, Pacific fisher, bull trout, Vaux's swift, and pileated woodpecker would be beneficially impacted in the long term. This would be a major beneficial impact from this alternative.



Living Marine Resources

Summary of Regulations and Policies

Subject to other valid existing rights, the state of Washington owns in fee all coastal aquatic lands from the mean high tide seaward three miles, including the intertidal and subtidal zones (WDNR 1992). These aquatic lands are primarily managed by the Washington Department of Natural Resources and are held in trust for the people of Washington. State management objectives are to sustain long-term ecosystem and economic viability, and to ensure public access and benefits derived from aquatic lands. Marine macroalgae on state-owned aquatic lands are the property of the state, and harvest of these speceies is managed by the department. Shellfish on state-owned lands, including oysters, clams, mussels, scallops, and shrimp, also are managed by the department. Waterfowl, and anadromous and nonadromous fish are managed by the Washington Department of Fish and Wildlife.

Methodologies for Analyzing Impacts

Intertidal and subtidal surveys were conducted in the summer of 1994. (See Affected Environment chapter, Living Marine Resources section for results). The intertidal zone was surveyed at low tide, while 78 underwater transects were examined by scuba both to the east and west of the river mouth. The particle size and quantity of sediment moving from the reservoirs to the sea was modeled by alternative (see Impacts on Fluvial Processes and Sediment Transport section). The movement and deposition of these sediments in the marine environment was then estimated based on information on currents in the area.

Impacts of No Action

The Glines Canyon and Elwha projects have altered the estuarine and nearshore marine environment by reducing the sediment supply an estimated 280,000 cubic yards annually (James River II 1989). Due to this loss of sediment replenishment, the shoreline has both receded and steepened, and the intertidal and shallow subtidal zone now has a bottom dominated by larger cobbles instead of sand and gravel. Based on a 1926 map of the river mouth, the Elwha River delta historically extended an additional 0.5 miles. Assuming that the sediment supply had been maintained, the delta would have extended at least this far, if not farther.

In general, the nearshore marine community includes fish such as salmon, greenling, flatfish, rockfish, sculpins, clingfish, sand lance, herring; more than 50 species of marine algae (including kelp); birds, including gulls, common murres, marbled murrelets, rhinoceros auklets, and harlequin ducks; and mammals including the Pacific harbor seal and, infrequently, Steller and California sea lions, orcas, and gray whales (Calambokidis et al. 1987, FWS 1995c). Nearshore substrates composed of boulders and cobbles, support species that prefer rocky environments, such as kelp, many species of red algae, red and yellow sponges, red rock crab, barnacles, mussels, limpets, chitons, and periwinkles. Local kelp beds are particularly important as habitat for various species of baitfish, which are prey species for salmon, and recruitment and nursery habitats for juvenile marine fish including Pacific herring, rockfish, and lingcod.

Intertidal and underwater surveys in the summer of 1994 found that the mid to upper portion of the intertidal zone near the river mouth consists of a steep beach with coarse substrate (e.g., cobbles and boulders) subject to high wave action, and relatively sparse marine animal and plant life (FWS 1995c).

In contrast, the low intertidal and shallow subtidal zones support a diverse and highly productive community of plants and animals, including more than 30 species of macroalgae. Animal species frequently observed included greenling, sculpins, red rock crab, snails, and chitons.

As delta material is deposited offshore, it forms an estuary (see Living Marine Resources, Affected Environment section). This zone of "brackish water" where fresh and salt water mix is important to anadromous fish to help them transition from a freshwater to marine existence, and to many aquatic species as habitat or nurseries. Valuable commercial species that depend on estuaries include crabs, shrimp, hardshell clams, oysters, and mussels. Juveniles of non-salmonid fish species such as herring, anchovy, smelt, tomcod, lingcod, sculpin, and English sole also need estuaries to feed and grow.

There is no historical written record of what vegetation and substrate were present at the mouth. Based on similar nearby rivers, it is likely that the substrate would have included substantially more sand and gravel, in addition to the cobble and boulder substrate that dominates now. In addition, the beach slope would have been much more gradual, providing a wider intertidal zone. As a result of the changes in beach slope, substrate composition, and salinity, the habitat and the species it supported has changed dramatically from pre-dam conditions.

The former estuary probably supported eelgrass beds and other macroalgae, creating a more complex estuarine habitat, and provided an important nursery area for salmonids, marine fish, and shellfish. A richer diversity of habitats supported a more complex community of juvenile finfish, hardshell clams, and other invertebrates, and increased productivity at the river mouth and in Freshwater Bay. The erosion and deepening of this area has caused the estuary to recede, resulting in the loss of a highly productive habitat type. In its place, a very different marine plant and animal community has become established, which is also highly productive.

The region near the Elwha River mouth is currently dominated by very large substrate and steep banks, and supports only a small population of hardshell clams. The composition and abundance of shellfish prior to dam construction is not known; however, hardshell clams, typically a major intertidal shellfish resource, are likely to have been more abundant. Both the change in substrate composition from sand-gravel-cobble to a more coarse gravel-cobble-boulder mix and a reduced intertidal area associated with the loss of sediment trapped behind the dams probably reduced clam populations.

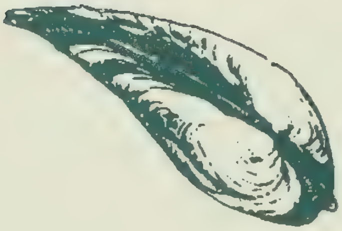
Conclusion

The region near the Elwha River mouth is dominated by very large substrate and steep banks as a direct result of the near elimination of natural sand and gravel transport from the Elwha to the marine environment caused by the dams. The marine community of plant and animal species in the mid to high intertidal zone changed from its pre-dam configuration and is now much less abundant. Within the low intertidal and shallow subtidal zones, the composition of species also changed dramatically, now favoring species that prefer or require a rocky substrate. Both the existing biological community and the one it replaced are considered highly productive and valuable.

The Elwha River delta and estuary are much smaller than maps indicate they were before sediment transport was stopped by the dams. As a consequence, important estuarine values and functions, including a nursery area for anadromous and marine fish, crabs, and other shellfish; an acclimation zone for fish passing from fresh to salt water; and an area of high primary productivity, have been adversely affected. The ability of fish to rear and several aquatic species to flourish has been adversely affected as a result.

Selecting the No Action alternative would mean that existing populations would remain, the delta and estuary would be undersized, and clam populations would be lower than under pre-dam conditions.

Impacts of the Proposed Action – River Erosion Alternative



Under the proposed action, the increase in sediment supply to the marine environment during and following the removal of the dams would result in higher levels of turbidity and a change in the beach profile and substrate, as well as the biological community it presently supports. During the removal of Elwha and Glines Canyon dams, river water containing very high concentrations of silt and clay would be periodically released to the marine environment. The periods of highest turbidity would coincide with the notching of the dams and the resulting downcutting and erosion of the reservoir lakebeds and deltas. The river is expected to clear substantially during the periods when the lakebeds and deltas are not eroding.

Following the removal of the dams, some silt and clay remaining in lake bed terraces would be eroded or carried into the river downstream to the marine environment primarily during successively higher flood events. During dam removal and for two to four years following, the high concentrations of silt and clay carried by the river would result in major localized impacts to the nearshore biological community. Since wave action and strong currents would be expected to keep silt and clay from settling near shore, the impact of turbidity would be primarily related to its adverse effect on the photosynthetic activity of marine macroalgae.

Depression of the macroalgae community could subsequently impact the fish, shellfish, crustaceans, and other marine animals that it supports. Turbidity impacts to nearshore marine plants and animals would be lessened by the periods of river clearing called for in the dam removal scenario, and by the shifting of the strong tidal currents. While some reduction in the abundance and distribution of the marine nearshore community would be expected, these turbidity induced impacts should be short-term, with restoration occurring within a few years following dam removal. Although short-term effects would potentially be major, impacts from turbidity on the marine ecosystem would be minor.

The greater impact to the existing nearshore marine community would result from river transport of coarse sediments (primarily sand and gravel) and their subsequent deposition in the intertidal and shallow subtidal zone. The intertidal zone and subtidal zone, out to a depth of approximately 20 feet near the river mouth and extending eastward to the sea bluffs, now consists of species dependent on large substrate, i.e., predominantly cobbles and boulders as a result of the dams holding back sediment. Also, beaches have steepened.

The existing biological community — kelp, rockfish, greenling, red rock crab, and chitons — consists of species that prefer or are adapted to the larger sized substrate. Following dam removal, the biological community in the intertidal and shallow subtidal zone out to a depth of 20 feet is expected to change in response to the increase in the percentage of sand and gravel. The composition should shift and benefit such species such as Dungeness crab, littleneck, butter, horse and geoduck clams, sand lance, surf smelt, eelgrass, and species of green algae, with a decline in the abundance of those species that require or prefer large substrate. Although this is a major localized impact to species now on the rocky substrate, it would restore the pre-dam community of marine life. Also, the intertidal zone is expected to increase in size and become more productive as the beach slope returned to its more gradual pre-dam profile. A valuable and productive biological community would be replaced with a different, but also valuable and productive, community.

The increased sediment load of the river should have only a minor effect on the existing species (1) west of the river mouth, because of the easterly direction of the longshore transport; (2) east of the eroding sea bluffs because of the existing high percentage of sand and gravel, and (3) in offshore water deeper than 20 feet since the local wave energy is generally insufficient to transport coarse sediments beyond this depth. Between the eroding sea bluffs and Ediz Hook, the beach slope may become more gradual and increase the size of the intertidal zone in response to the restored sediment supply; however, the substrate composition should remain essentially the same, predominately sand and gravel with some cobble and boulders. The existing biological community in these more distant areas (flatfish, sand lance, Dungeness crab, basket cockle, and geoduck clams, cragon shrimp, and green algae), which is adapted to fine-grained substrate, should not be affected by the increased sediment supply.

Return of natural sediment transport to the river mouth should rebuild the estuarine environment to more natural conditions. The river delta, over time, may extend an additional 0.5 mile. The associated enlarged estuary would support eelgrass and other macroalgae, creating a more complex community, and would provide an important nursery area for salmonids, marine fish, and shellfish. As discussed above, shellfishing would improve in the vicinity of the river mouth and in the intertidal and shallow subtidal zones. Littleneck, butter, horse, and geoduck clam populations should increase.

Cumulative Impacts

Marine life well east of the Elwha River mouth has been affected by reduced sediment not only from the Elwha, but also from the armoring in 1930 and 1958 of eroding sea bluffs to the east of the mouth. The cliffs originally supplied approximately 270,000 cubic yards of sediment to the nearshore environment each year. This was reduced to an estimated 90,000 cubic yards annually when the bluffs were stabilized to protect a water supply line into Port Angeles (Schwartz 1994). Since waves in the vicinity have the ability to transport 270,000 cubic yards of material per year, beaches and the nearshore habitat have been steepened and now provide a greatly reduced intertidal zone. The intertidal zone is important for many species of fish because of its high production of prey items. Now, larger substrate and the marine life that traditionally occupy this kind of rocky habitat (kelp, rock crab, barnacles) have replaced the original species (eelgrass, flatfish, juvenile lingcod, cragon shrimp, and Dungeness crab).

Regionally, with the significant exception of salmon stocks, there are few sources of adverse impacts on marine resources. Most of the coastal strip on the west side of the Olympic Peninsula is protected by Olympic National Park and two national wildlife refuges. Marine waters are protected by the Olympic National Marine Sanctuary. The north side of the peninsula, although not in protective land status, is relatively natural, affected primarily by sediment input from coastal logging activities and commercial shellfishing. The east side on Puget Sound is affected by logging, residential, and industrial activities. The return of natural Elwha River salmon runs and the restoration of the river delta would beneficially affect the overall health of the marine environment.

Future conditions, however, would approximate those that existed prior to dam construction.

Conclusion

Moderate adverse impacts would occur to local marine communities from large quantities of silt and clay transported by the river during and following the construction period. The increase in transport of sand and gravel would result in a major change in the substrate composition and associated biological community between the river mouth and the eroding bluffs to the east. Future conditions, however, would approximate those that existed prior to dam construction.

Impacts of the Dredge and Slurry Alternative

The impacts would be similar to the River Erosion alternative (the proposed action). Not all fine sediments would be transported through the pipeline, since 1.2–1.4 million cubic yards would be inaccessible to the dredge. A portion of these fines would erode with the delta or afterward, and a portion would permanently remain outside the floodplain.

Most fines would be transported to salt water through the pipeline. However, because of the dredging operation, a larger total quantity of fines would be expected to reach salt water via the pipeline and the river combined than under the proposed action.

The outfall of the pipeline would be located off Angeles Point, approximately 1 mile from the river mouth, in water 60 to 100 feet deep. This would ensure the least impact to living marine resources. Underwater surveys found that beyond a depth of 50 feet, kelp and other macroalgae concentrations decrease substantially. Sediment discharged from the pipe would consist primarily of silt and clay, with some fine sand. Compared to the proposed action, this material would be dispersed more quickly and would be more diluted by the deeper water. Some impacts would occur to the macroalgae community in this deeper water, but they would impact a less productive community.

and the Lower Elwha Klallam Tribal Fish Hatchery is considered mandatory and included as part of the Dredge and Slurry alternative. Other mitigation described in the proposed action and in this section are recommended for adoption. Minor to major impacts are expected to users without mitigation, and minor or no impact with mitigation.

Conclusion

Moderate adverse impacts would occur to local marine communities from large quantities of silt and clay transported by the river during and following the construction period. The increase in transport of sand and gravel would result in a major change in the substrate composition and associated biological community between the river mouth and the eroding bluffs to the east. Future community structure, however, would approximate that which existed prior to dam construction.

Air Quality

Summary of Regulations and Policies

The Olympic Air Pollution Control Authority enforces air quality regulations in Clallam County. Main concerns about demolition would be fugitive dust emissions and the presence of asbestos at the damsites (OAPCA 1995). Although short-term construction activities, such as the proposed Elwha and Glines Canyon dams demolition, are generally exempt from the authority's permitting requirements (regulations, reference 4), it does require mitigative measures to reduce fugitive dust emissions during demolition.

Methodologies for Analyzing Impacts

The air quality impact analysis for the proposed Elwha and Glines Canyon dams demolition is based on construction activities that generate fugitive dust emissions — haul roads, loading and dumping concrete and saturated fill, bulldozing, saw cutting, and wind erosion of bared reservoirs. Fugitive dust emissions are dependent on the specific operations performed, meteorological conditions, and levels of activity. Emissions also are dependent on the silt content in the soil, material moisture percentage, and vehicle weight and speed. For the air quality analysis, silt is assumed to be particles less than 75 micrometers (0.075 millimeter) in diameter.

Construction activities at the damsites would continue for approximately two years. Demolition methods would include drilling and blasting of the concrete structures at both dams and diamond wire saw cutting at the Glines Canyon Dam. Work would be performed during two ten-hour shifts, six days per week. Dust emission sources at both dams include haul roads, dumping, bulldozing, saw cutting, and wind erosion. Primary pollutants of concern in this analysis are fine particulate matter less than 10 micrometers in diameter and total suspended particulates.

PM_{10} emissions from the roads were modeled using the SCREEN3 program to predict the resulting ambient concentrations (EPA 1995). The SCREEN3 program utilizes worst case meteorological conditions, actual emissions rates, and source configuration to predict maximum downwind concentrations.

Haul Roads. The demolition process at the Elwha and Glines Canyon dams would produce soil, rock, and concrete waste material, some of which would be buried at the site. Excess waste material (mainly concrete rubble and saturated fill material composed of gravel and large rockfill) would be hauled to one or more designated disposal sites, all within 32 miles of the site.

Loading/Dumping Emissions. Waste material composed of concrete and saturated fill would be loaded onto trucks using front loaders and hauled from the damsites to disposal area(s).

Bulldozing. Demolition operations at the dams would include approximately one month (480 hours) of bulldozing of waste materials.

Saw cutting Emissions. Diamond wire saws would be used for cutting blocks of concrete at the Glines Canyon Dam. Water would be applied to cool the saws during operation. Due to the water application, particulate emissions from saw cutting would be minor, and are not considered in this analysis.

Wind Erosion. During the dam removal process, Lake Aldwell and Lake Mills would be completely drawn down. The exposed lake sediments would be subject to wind erosion, primarily from gusts.

Impacts of No Action

The projects have not affected air quality, except indirectly by providing 172 annual gigawatt hours of clean power.

Presently, Clallam County and the project site meet standards for all criteria pollutants. Silvicultural burns, pulp mill emissions, dust and other particulate matter generated from vehicles on unpaved roads, vehicle exhaust, and smoke from campfires, slash and burn and occasional forest fires affect air quality in the middle and lower Elwha valley area and Olympic National Park. The park is subjected to episodes of smoke and particulate matter pollution from slash burning on adjacent lands and occasional forest fires; these short-term events affect visibility but have limited impact on other park resources.

The impacts of these sources of air pollution (i.e., impacts of No Action) are shown below in table 51 compared to national air quality standards.

Conclusion

The hydroelectric projects do not adversely affect air quality, which is in attainment for all criteria pollutants in Clallam County.

Table 51. *Air Quality Data and Standards for Olympic National Park (1994)*

POLLUTANT AND AVERAGING TIME PERIOD	NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)	HIGHEST 2ND-HIGH MONITORED CONCENTRATIONS IN OLYMPIC NP	HIGHEST 2ND-HIGH MONITORED CONCENTRATIONS NEAR OLYMPIC NP
SO_2 3-Hour[a] (µg/m^3)	1300	53	—
SO_2 24-Hour (µg/m^3)	365	19	—
SO_2 Annual (µg/m^3)	80	5.9	—
NO_2 Annual (µg/m^3)	100	—	28
O_3 1-Hour[b] (ppm)	.12	0.067	—
PM_{10} 24-Hour (µg/m^3)	150	—	28
PM_{10} Annual (µg/m^3)	50	—	13.9
CO 1-Hour (ppm)	35	—	5.8
CO 8-Hour (ppm)	9	—	3.8

[a] micrograms per cubic meter (µg/m^3)

[b] parts per million (ppm)

Table 52. *Annual Particulate Matter Emissions Less than 10 Micrometers (PM_{10})*

ACTIVITY	ELWHA DAM PM_{10} EMISSIONS (TONS)			GLINES CANYON DAM PM_{10} EMISSIONS (TONS)		
	Year 1	**Year 2**	**Total**	**Year 1**	**Year 2**	**Total**
Haul Roads	1.2	96.6	97.8	6.9	6.9	13.8
Loading	.00037	.03	.03	.0011	.0011	.0022
Dumping	.00037	.03	.03	.0011	.0011	.0022
Bulldozing	—	—	0.16	—	—	.0065
Wind Erosion	—	—	7.3	—	—	11.4
TOTAL	**1.2**	**96.7**	**105.3**	**6.9**	**6.9**	**25.2**

Impacts of the Proposed Action – River Erosion Alternative

Annual PM_{10} emissions from various construction activities at the Elwha and Glines Canyon damsites are presented in table 52. Each of these sources is discussed below. In addition to particulate emissions, trucks and other equipment would emit small amounts of other pollutants related to internal combustion or diesel engines such as oxides of nitrogen, carbon monoxide and oxides of sulfur. These are considered minor and are not regulated.

Haul Roads. The largest source of PM_{10} emissions would be from trucks using haul roads. During the first year of construction, total fine particulate (PM_{10} — inhalable particulate matter) emissions from paved and unpaved roads between the Elwha damsite and the disposal area would be about 1.2 tons. Due to increased truck traffic during the second year, these emissions would increase to approximately 96.6 tons. Total PM_{10} emissions from truck traffic for the two-year period would be 97.8 tons. Total suspended particulates (TSP) emissions for the first year would be 5.7 tons and increase to 457 tons the second year. At 100 meters from the haul road, the predicted 24-hour concentrations plus the background concentrations (table 51) are 144 micrograms per cubic meter ($\mu g/m^3$), less than the $150 \mu g/m^3$ standard. This would be a minor to potentially moderate short-term impact to any residents along a one-half mile stretch of unpaved haul road if unmitigated.

The emissions in table 52 do not account for mitigation measures. However, at a minimum, water would be applied to portions of the haul roads during dry weather to reduce emissions by 50%, decreasing the magnitude of impact to minor. Speed limits or paving would reduce impacts even further.

Traffic for the two years of construction on Glines Canyon Dam would result in approximately 6.9 tons of PM_{10} emissions each year (see table 52). Estimates for the total PM_{10} and TSP emissions for the duration are 13.8 and 71 tons, respectively.

Loading or Dumping Emissions. PM_{10} and TSP emissions from loading or dumping of waste material for the Elwha Dam during the first year are estimated to be 0.00037 tons (0.7 pounds) and 0.0008 tons (1.6 pounds), respectively. During the second year of demolition, PM_{10} and TSP emissions are estimated at 0.03 tons (60 pounds) and 0.06 tons (120 pounds), respectively.

PM_{10} and TSP emissions for the Glines Canyon Dam are estimated at 0.001 tons (2 pounds) and 0.0024 tons (5 pounds), respectively, for each year. Loading and dumping PM_{10} and TSP emissions are estimated to be 0.002 tons and 0.005 tons, respectively.

Bulldozing Emissions. Estimated total PM_{10} and TSP emissions from bulldozing at the Elwha damsite are 0.16 and 3.6 tons, respectively, based on approximately one month of bulldozing near the end of the project. Bulldozing emissions for the Glines Canyon Dam are 0.00648 tons (13 pounds) for PM_{10} and 0.2 tons (400 pounds) for TSP.

Wind Erosion. The erosion potential for Lake Aldwell sediments derived using Environmental Protection Agency equations is 17.30 g/square meter. Based on 267 acres of dry exposed sediments, total PM_{10} emissions would be 7.3 tons. Lake Mills, without vegetation cover and in dry conditions, would have approximately 415 acres of surface exposed to wind erosion, result in approximately 11.4 tons of PM_{10} emissions. This calculation assumes that a single high-speed wind event removes all erodible material from the surface.

Realistically, previous wind events of lesser intensity would have removed some of the erodible material.

Cumulative Impacts

Source of particulates in the area include those from the use of unpaved roads, agricultural operations, wind blown dust, slash and burn operations, campfires and occasional forest fires. Dust from the projects would be of short-term duration and not large when compared to these natural sources.

Conclusion

Elwha dam demolition would be estimated to generate a total of 105.3 tons of PM_{10} during the two-year period. Most of these emissions (97.8 tons) would be from the use of haul roads, although wind-blown dust from bared reservoirs could have moderate impacts on visibility as well. At 100 meters from the road where dust emissions are highest, concentrations would be less than the 150 microgram per cubic meter standard but may have short-term moderate impacts if unmitigated to residents living along a one-half mile unpaved section. Mitigation would reduce the magnitude of these impacts to minor. PM_{10} emissions for the Glines Canyon Dam are estimated at 25.2 tons. The demolition process would have no permanent impact on local or regional air quality.

Impacts of the Dredge and Slurry Alternative

Air quality impacts for the Dredge and Slurry Pipeline alternative are nearly the same as for the River Erosion alternative (the proposed action). Trenching to bury the pipeline would create some additional dust, and running the pumps needed to lift the slurried material would create additional but minor emissions. These additional sources of air pollution would not be large enough to change quantitative estimates for the proposed action.

Noise

Summary of Regulations and Policies

Noise produced by demolition activities would vary widely, depending on the specific equipment. Construction activities are excluded from Washington Department of Ecology noise ordinances (WAC 173-60-040).

The 1988 National Park Service Management Policies state that the park service will strive to preserve the quiet and the natural sounds associated with a park's physical and biological resources. Activities causing excessive or unnecessary unnatural sounds in and adjacent to parks will be monitored, and action will be taken to minimize unnatural sounds that adversely affect park resources or values or visitors' enjoyment of them.

Methodologies for Analyzing Impacts

Noise impact analysis for the Elwha and Glines Canyon dams includes noise generated by blasting various structures at the two sites and noise from equipment such as bulldozers and dump trucks that would be used during the two-year demolition period.

The concrete dams and associated structures would be demolished using several methods. This analysis deals with noise generated by blasting activities and noise produced by ordinary construction equipment. Noise levels produced by construction equipment at a reference distance of 50 feet were obtained from literature. These levels are presented in table 53 for equipment expected to be used in the Elwha River Restoration Project.

These levels were then used in a noise prediction model (NOISECalc) to determine the expected noise levels at various distances from the sites. It was assumed that all equipment would be in operation simultaneously to produce a worst-case analysis. It was further assumed that no shielding would be provided by terrain and trees. Thus, the calculated results are very conservative; actual levels should always be lower than those predicted.

Blast levels were predicted using a procedure developed by the US Army Corps of Engineers (Raspet and Bobak 1987). The procedure accounts for the depth of burial, quantity and type of explosive, and meteorological conditions.

For this analysis, the flat-weighted peak noise level is appropriate. The flat-weighted noise level is used in situations where the noise is one short "thump" of sound; it includes the full sound range, not only what people can hear. The flat-weighted peak level is not a familiar measure of noise, even to industrial workers. In flat-weighting, there is no subtraction from very low and very high frequency sounds to account for the response of the human ear

Table 53. *Construction Equipment Noise Levels*

EQUIPMENT	NOISE LEVEL AT 50 FEET (dBA)
Track Hoe (Back Hoe)	80
Dozer (Cat D-8)	80
Crane (Manitowac 4100)	83
Air-Track (rock drill)	93
Hoe-Ram (large jack hammer attached to a backhoe or similar equipment)	93
Front-End Loader	79
Heavy Trucks	88
Air Compressor	81
Generator	78

to varying frequencies of noise. This results in rather high numbers when compared with typical noise measures. Table 54 provides descriptions and effects of peak levels in the range of those expected from proposed blasting.

Impacts of No Action

The power generation equipment of the Elwha and Glines Canyon dams is a minor source of noise; turbine whine, high voltage electrical transmission line hum, and intermittent water crashing through the spillways all contribute to unnatural sound levels. Noise levels are generally magnified on Lake Mills due to the very steep canyon in which it is situated, although the nearest residents and known nests of species of special concern (in this case, northern spotted owl) are one mile away and further, and so are unaffected by these sources. Recreational users may experience some temporary and minor impact from these sources of noise if they are very close to them.

In addition, noise in the project area is caused by vehicles traveling on Olympic Hot Springs and Whiskey Bend roads, heavy traffic on Highway 101 (including logging trucks and other heavy duty vehicles), occasional aircraft overflights, and motor boats on the lakes. None of these sources contributes more than minor impacts to noise levels in the area.

Table 54. *Peak Flat-Weighted Sound Pressure Levels*

SOUND LEVEL (dBP)	DESCRIPTION AND EFFECTS
119	No effects.
120	Likened to distant thunder: no appreciable effects on humans; attention might be increased in non-habituated animals.
128	Likened to moderate thunder: startle reflex might appear in persons with normal hearing, up to 50% of non-habituated sleepers in quiet areas might awaken, windows may rattle, slight vibrations in houses. Less than 10% "very annoyed" in exposed communities.
134	Cracking sound, penetrates background noise: startle response in up to 20% of exposed non-habituated population, sheep and birds show reactions, habituation probably occurs for humans and animals, windows rattle, vibrations in houses.
140	Loud cracking sound: startle response in up to 50% percent of exposed non-habituated population, heavy sleepers awaken, house vibrates, windows may crack in pre-stressed parts, faulty plaster might fall.
148	Strong cracking thunder: startle reactions among majority of exposed, babies might start to cry, sleepers awaken, bric-a-brac might fall from shelves, small number of broken windows in earlier non-exposed areas.

SOURCE: Gaydos 1984

Conclusion

Noise from the hydroelectric projects has negligible impacts on residents in the area now.

Impacts of the Proposed Action – River Erosion Alternative

Two types of noise levels were analyzed — the impacts of continuous noise at various distances from the construction site (assuming all equipment operating simultaneously) and the impacts from single, loud noises such as blasting.

Continuous Noise

Typical noise levels for construction equipment that might be used are presented in table 53 (see Methodology Section). While workers at the site would be subject to and protected by OSHA regulations and requirements, residents would not. Because the area would be closed during construction, park visitors would not be affected. Residents of approximately 20 homes within one-half mile of the Elwha damsite (table 55) could experience noise levels as high as 58 decibels under poor atmospheric conditions. This is comparable to noise in a typical office (table 56) and is a short-term, minor adverse impact. No residents or wildlife species of special concern live within one-half mile of the Glines Canyon damsite.

Residents of the approximately 55 homes and wildlife within a 1.2-mile radius of Elwha Dam would not be aware of day-to-day construction noise, as decibel levels under even the worst atmospheric conditions would approximate those in household sleeping at night (i.e., 40 — 49). Nest of species of special concern (in this case Northern spotted owls) have been located one mile from the Glines Canyon damsite and 1.2 miles from Elwha Dam. No adverse impacts from construction noise to this species is expected. Surveys for marbled murrelts have identified no nests near the dam sites, but the birds may be affected by short-term noise when they fly to and from the strait using the Elwha valley corridor, which includes the construction sites. Actual noise levels could be 20 decibels less than those predicted due to attenuation provided by trees and terrain that were not considered in this assessment.

Acute instances of noise

Although the impacts of day-to-day construction noise at the damsite are minimal to residents, occasional instances of very loud noise, such as blasting, may affect people differently.

Table 55. *Number of Houses at Reference Distances from Damsites*

NUMBER OF HOUSES/ DISTANCE	0.3 MILES	0.6 MILES	1.2 MILES	3 MILES
From Glines Canyon Dam	—	—	—	4
From Elwha Dam	—	20	55	491

Table 56. *Typical Sound Levels (continuous noise)*

SOUND LEVEL (dBA)	LOCATION/SOURCE	SUBJECTIVE IMPRESSION
100	Chain Saw @ 3 ft.	Very Loud
90	Train @ 100 ft.	
80	Truck Traffic @ 50 ft.	Moderately Loud
70	Auto Traffic @ 50 ft.	
60	Normal Conversation	Typical
50	Typical Office	
40	Household at Night	Quiet
30	Soft Whisper	
20	Sound Test Booth	Very Quiet
10	Breathing	
0	Threshold of Hearing	No Sound

Sources of this kind of noise are presented below and in table 58 by specific activity anticipated at Elwha and Glines Canyon damsites (BOR 1995c). Peak sound pressure levels were determined for weather conditions that would result in the lowest sound levels and those that would result in the highest sound levels. Actual levels should lie between the two curves. Levels were calculated for four distances from the sites ranging from 0.5 km (0.3 miles) to 5 km (3.1 miles).

Impacts of these noise levels depend on the distances of residents and wildlife from the site. The number of residents at each of a number of reference distances is presented in table 55. No known species of special concern nest closer than approximately 1 mile from either damsite.

Elwha Dam Diversion Channel: Approximately six large blasts during the month of May, with one or two days between blasts, would be anticipated for excavating the diversion channel. An additional five blasts would be needed to remove the rock plug following channel excavation.

Predicted peak noise levels for diversion channel blasting is shown in table 58. The levels range from 126 to 136 decibels at 0.3 miles down to 97 to 114

Table 57. *Estimated Decibels for Continuous Construction Noise at Reference Distances under Best and Worst Atmospheric Conditions*

DISTANCE	0.3 MILES	0.6 MILES	1.2 MILES	3 MILES	6 MILES
Sound level (dBA) under best/ worst atmospheric conditions	64/66	54/58	40/49	8/31	0/10

Table 58. *Predicted Flat-Weighted Peak Sound Pressure Levels Under Best and Worst Atmospheric Conditions*
(dBA)

ACTIVITY\DISTANCE	0.3 MILES	0.6 MILES	1.2 MILES	3.1 MILES
Elwha diversion channel blasting	126-136	117-129	109-123	97-114
Upper 30' of Elwha Dam removal	116-126	107-119	99-113	87-104
Lower 70' of Elwha Dam removal	124-134	115-127	107-121	95-112
Removal of other concrete structures	107-117	98-110	90-104	78-95
Glines Canyon Dam ongoing pre-splitting	124 -134	115-127	107-121	95-112
Glines Canyon Dam notch & removal	123-133	114-126	106-120	94-111

decibels at 3 miles. At one mile from the site, the sound would be like distant thunder with no appreciable effects to humans or wildlife. The Shady Tree RV Park and a few residences along Highway 101 and Dan Kelly Road within 0.6 miles would hear occasional noise similar to distant or moderate thunder.

Elwha Dam Removal. Elwha Dam removal would be planned in two stages. The first stage in July and August would be removal of the upper 30-foot portion. The lower 70 feet would be removed between December and April. Concrete blasts would be smaller than the bedrock diversion channel excavation; there would be an average of one blast per day. Predicted peak noise levels for removal of the upper and lower sections of the dam are shown in table 58. Levels are approximately 5 decibels lower for the upper section because the blasting charges would be about half the size of those for the lower section. The upper section levels would range from 107–129 decibels at 0.6 miles, the lower section levels from 115–127 at the same distance. Under the worst atmospheric conditions, this sound would be similar to that of moderate thunder for residents.

Other Structures at Elwha Dam. Noise levels for the removal of other structures at the Elwha Dam are given in table 58. These include the two spillways, the penstock intake structure, and the powerhouse. Since these are not critical in the construction sequence, it is difficult to estimate the timing of these blasts. The blasts would sound like distant to moderate thunder within 1 mile of the site, and would not impact humans or wildlife beyond 1 mile. Predicted peak levels at 0.6 mile range from 98 decibels during the best atmospheric conditions to 110 under the worst.

Glines Canyon Dam. Pre-splitting, required to break the upper 130-foot portion of the arch dam concrete into blocks small enough to handle, would be intermittently scheduled during the entire dam removal process. Expected peak sound levels at approximately 1 mile range between 107 and 121 decibels from the best to the worst weather conditions, respectively, similar to distant thunder. These would have no appreciable effects on humans and minor momentary effects on wildlife. No residences are within 1 mile of the site.

Blasting for diversion notches and for the lower portion of the dam would be similar in nature. This blasting would be done between August and May, with additional blasting likely between July and October. Blast sounds within 1 mile would be like distant thunder with the potential for only minor effects to wildlife. Beyond 1 mile there would be no impacts to humans or wildlife. The penstock intake structure would probably be blasted, similar to those outlined for removal of the associated concrete structures at Elwha Dam.

Notch blasting with 50 pounds of explosive per delay would produce peak levels of approximately 106 and 120 decibels at a distance of 1.2 miles, approximating the sound of distant thunder and having no appreciable impacts on humans or wildlife.

Transport Noise. The traffic volume and noise levels of trucks and equipment moving to and from the sites would be comparable to background conditions in urban or industrial areas, and would have only minor short-term impacts on existing noise levels. If travel through a residential location were required (to access one of nine solid waste disposal options presented; See Impacts chapter, Traffic section), trucks hauling rubble would sound similar to logging trucks.

Cumulative Impacts

Blasting at the Elwha and Glines Canyon damsites would be done during various phases of construction and would be composed of small individual explosions with timed delays that would not be additive. Since the project sites are now relatively quiet, there would be no cumulative impacts, i.e. impacts from other sources in the vicinity.

Minor short-term changes in ambient noise levels may increase due to various construction activities. Equipment such as bulldozers, front-end loaders, and dump trucks would generate noise typical of construction sites. Background noise from heavy traffic on Highway 101, Olympic Hot Springs and Whiskey Bend roads, and on the roads next to the lakes would remain high thereby making construction noise levels less distinguishable. Shielding provided by terrain, trees, and other vegetation also would reduce noise levels originating from the construction sites.

Elwha valley. (Charles Scott photo)

Conclusion

No residents or wildlife of special concern live closer than 0.3 miles to either damsite. Twenty residents live within 0.6 miles of Elwha Dam, 55 within 1.2 miles and 491 within 3 miles of the site. The closest residents to Glines Canyon Dam are 2 miles away, and four live within a 3-mile radius. Nests of species of special concern (northern spotted owls) have been located 1 mile from Glines Canyon Dam, and 1.2 miles from Elwha Dam.

Continuous noise levels from construction equipment could have short-term (18 months to 2 years) minor adverse impacts on residents living within one-half mile of the Elwha damsite, but would not be noticeable beyond 1.2 miles. Ambient weather conditions, and topography may reduce noise levels. Nesting species of special concern identified in the area to date (surveys for marbled murrelets continue) would not be affected.

Residents within 0.6 miles of Elwha Dam would periodically experience short periods of acute noise from intermittent blasting similar in intensity to that of moderate thunder. Residents and wildlife beyond 1.2 miles would not be expected to experience blasting noise; predicted noise levels during the worst-case atmospheric conditions are all below or close to 120 decibels. Both noise levels would be temporary and considered a negligible impact.

At Glines Canyon Dam, pre-splitting and blasting during notching of the dam would produce about the same level of noise as the loudest actions at Elwha Dam. At a distance of 1 mile from the site, sound levels would have dropped to those comparable to distant thunder or lower. No human residents exist within 2 miles of the site; at this distance the sound has no effect.

Actual noise levels could be up to 20 decibels less than those predicted due to attenuation provided by trees and terrain that were not considered in this assessment.

Traffic noise would be comparable to a logging truck and would occur primarily along routes already used frequently by such trucks.

Impacts of the Dredge and Slurry Alternative

Noise levels for the Dredge and Slurry alternative would be quantitatively indistinguishable from the proposed action. The pumping stations required to pump the slurried fines from Elwha Dam, and the trenching or laying of the pipeline would result in minor noise that would affect residents in the immediate vicinity.

Conclusion

Although there would be some slight increases in noise from pumping stations, dredges and trenching to lay the pipeline, they would be quantitatively indistinguishable from the Proposed Action alternative. Residents in the immediate vicinity of trenching may experience minor, temporary increases in noise.

Cultural Resources

Summary of Laws, Regulations, Policies

All federal actions affecting cultural resources are subject to the provisions of the National Historic Preservation Act of 1966, as amended, the National Environmental Policy Act, the Native American Graves Repatriation Act, the American Indian Religious Freedom Act, the Advisory Council on Historic Preservation's implementing regulations *Protection of Historic Properties* (36 CFR 800), *The Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation* (FR 48:44716-40), and *Federal Agency Responsibilities under Section 110 of the National Historic Preservation Act* (FR 53:4727-46).

National Park Service Management Policies indicate that cultural resources are to be preserved and appreciation of the resources should be fostered through appropriate programs of research, treatment, protection, and interpretation. Other applicable legislation and regulations and specific management procedures are detailed in the *Cultural Resources Management Guidelines* (NPS-28).

Section 106 of the National Historic Preservation Act requires a federal agency to take into account the effects of its undertaking on properties included in, or eligible for inclusion in, the National Register of Historic Places. This also applies to properties not formally determined eligible, but which meet eligibility criteria. Section 110 of the act requires that federal agencies establish a program to identify, evaluate, and nominate properties to the National Register. It also requires agencies to act as necessary to minimize harm to historic properties adversely affected by a federal proposal, and gives the Advisory Council on Historic Preservation a chance to comment. In sum, the 106 process requires the identification of resources that would be affected by a federal proposal, their evaluation under National Register criteria, an assessment of proposed impacts on those resources, and consideration of ways to avoid, reduce, or mitigate adverse impacts.

Penstock and powerhouse, no date. (Clallam County Historical Society)

The hydroelectric projects themselves are now considered historically important early examples of dams and powerplants...

Methodologies for Analyzing Impacts

Assessment of impacts to cultural resources followed a four-step process outlined in the Advisory Council's revised regulations: (1) identifying the area of potential effect of the proposed action; (2) comparing that location with that of resources listed in or eligible for listing in the National Register of Historic Places; (3) identifying the extent and type of impact of the proposed action on National Register properties; and (4) assessing these effects according to procedures established in the regulations.

The National Park Service and Lower Elwha Klallam Tribe conducted intensive surveys to identify cultural resources within the area of potential effect of removal. Anthropological research that included oral interviews identified the presence of many areas of special concern to the Lower Elwha Klallam people. Archeological field surveys of public lands within the area of potential effect identified the presence of archeological sites as well as additional areas of high resource potential that relate to both Elwha Klallam and Euro-American occupation of the valley. Historical surveys identified buildings, structures and cultural landscapes that reflect the cultural diversity of the Elwha valley.

An effect on a historical property occurs if an undertaking has the potential of changing in any way the characteristics that qualify that property for inclusion in the National Register. If the proposed action diminishes the integrity of such characteristics, it is considered to have an adverse effect. Effects that may occur later than, or at a distance from the location of the undertaking (i.e. downstream of dam removal) are also potential impacts of the action. These are indirect effects.

Impacts of No Action

Building the dams had major adverse consequences on tribal cultural resources. The river provided not only the resources for sustenance and lifeways of the Elwha Klallam, but was at the heart of their ceremonial, cultural, and spiritual existence. Construction of the projects and the subsequent loss of the Elwha as a free flowing river cut at their core, destroying the fish vital to ceremony as well as economy. The dams decimated fish runs critical to their livelihoods and flooded villages, fish camps, homesteads, medicinal plant and food gathering and preparation sites, and, most likely, burial sites. The harvestable shellfish have been altered by changing marine substrate and reducing the size of the estuary at the river mouth (see Living Marine Resource and Fluvial Process/Sediment Transport sections for more information).

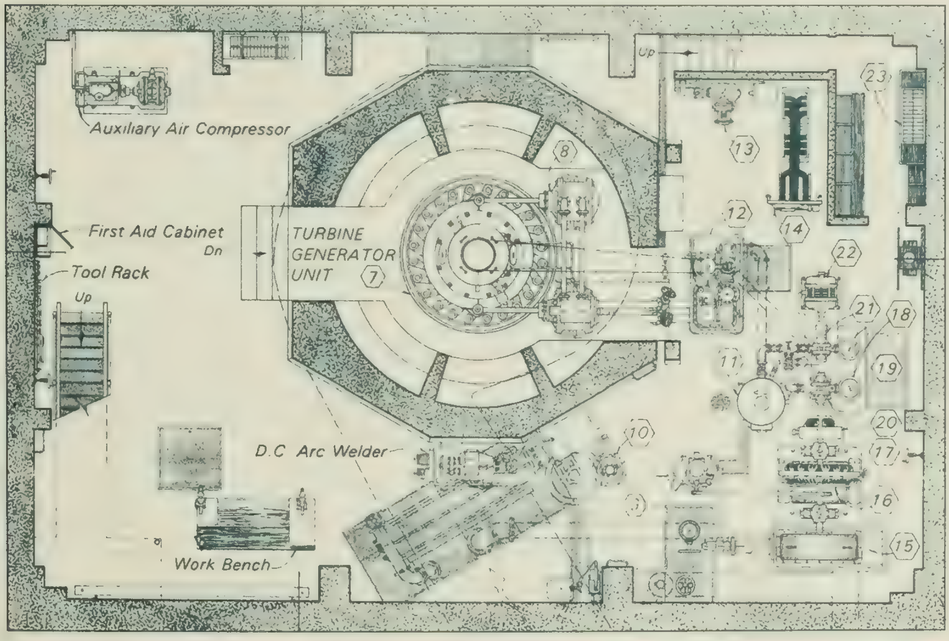
Some of the Lower Elwha Klallam's most spiritual sites were (and still are) rendered inaccessible to the Lower Elwha Klallam people by the dams and/or reservoirs. The Elwha Klallam believe that the Creator made their ancestors in the lower canyon of the Elwha River. In the place where they were created, the Elwha Klallam went to receive spiritual guidance and information about their future life. The creation site was made inaccessible by the Elwha Dam and Lake Aldwell. It is unknown whether the fluctuating levels of the reservoirs have eroded archeological sites in the area, but it is possible as the areas nearest the river were most likely to have been occupied.

The hydroelectric projects themselves are now considered historically important early examples of dams and powerplants and are listed in the National Register of Historic Places. Elwha Dam includes "...a rare, early example of the multiple-buttress type" structure and Glines Canyon Dam significant because of "its association with the evolution of power plant design and contribution to the development of the automation of hydroelectric installation."

The dams blocked the natural downstream transport of sediment, resulting in a lowered riverbed and lowered surface water elevation in some cases. This has reduced flooding in some spots and has stabilized flow in the river channel (i.e., reduced the frequency and distance of the river's meander). These decreases in erosion and flooding may have secondarily protected structures or cultural sites, particularly those built nearer to the time or after the time that the Elwha Dam was built (1910). These structures include the historic Elwha Ranger Station complex, former homesteads, railroad remains, and many other known (and unknown) archeological sites.

Conclusion

If No Action is selected, fisheries, including shellfish, which the Lower Elwha Klallam depend on for both cultural and sustenance reasons, would continue to decline as the result of impacts caused the by dams. Sites important to the cultural and spiritual lives of Lower Elwha Klallam Tribal members would remain inaccessible. The river would remain dammed and in an unnatural condition, a major, adverse and ongoing impact on tribal culture. The



Historical American Engineering Record drawing (draft, 1995) showing the Glines Canyon Dam powerhouse. (Olympic National Park, John M. Reed drawing) hydroelectric projects would continue as historically important early examples of dams and power plants. There would be no increased threat of the loss of structures, buildings or archeological sites in or near the floodplain from erosion action of the river meander or flooding.

Impacts of the Proposed Action – River Erosion Alternative

Construction-related Impacts

Dam Removal. Removal of Elwha Dam and Glines Canyon dams would result in the permanent loss of properties listed in the National Register of Historic Places. The Elwha Dam is considered an example of "...a rare, early example of the multiple-buttress type," and Glines Canyon Dam significant because of "its association with the evolution of power plant design and contribution to the development of the automation of hydroelectric installation." The loss is considered major and adverse.

To help mitigate the loss of the hydroelectric projects and to carry out Section 106 responsibilities, the National Park Service and Lower Elwha Klallam Tribe have consulted with the Washington State Historic Preservation Officer and Advisory Council on Historic Preservation, and have completed a programmatic agreement (see appendix 5) that establishes a process for cooperative action in the treatment of cultural resources within the project area. According to stipulations of the programmatic agreement, which was signed on June 6, 1995, the National Park Service would document the

Table 59. *Mitigation Measures Required under the Interagency Programmatic Agreement[a] and Section 106 of the National Historic Preservation Act*

IMPACT	MITIGATION
Erosion from increased river meander	Monitor; stabilize bank, or data recovery
Loss of tribal cultural properties	Survey, monitor, response plan
Erosion of terraces	Monitor, stabilize bank, or data recovery
Aggradation and flooding	Monitor, stabilize bank, data recovery or recording of significant features
Loss of historic projects (dams)	HABS/HAER recording of significant features, retain some elements on site, interpretation
Grading of roads	Survey prior to ground disturbance; avoid or data recovery
Disposal of waste rubble	Survey prior to dumping; response plan
Revegetation (digging may uncover resources)	Survey; response plan

[a] See Appendix 5

properties to standards of the Historic American Engineering Record. This documentation would include measured drawings of designated features, and photographs and archival copies of important engineering records and drawings. With the addition of these mitigative measures, the impact of removing these important historic structures is reduced for the purposes of this EIS (i.e. under NEPA) to minor. Other mitigation could include interpretation of the history of the dams and the removal process at sites within the park for visitors.

Removing the dams and flushing sediment could have a permanent major beneficial impact by making locations important to the cultural and spiritual lives of the Lower Elwha Klallam accessible to them. The "Creation Site," where the Elwha Klallam people were created, "Prophecy Hole," where they went to receive guidance and envision their future, and a "Cleansing Site," where they went to purify themselves and receive spiritual guidance are in the Elwha Dam and Lake Aldwell area. Conversely, dam removal activities could result in the destruction of archeological sites, other sites of special concern to the Lower Elwha Klallam in the immediate vicinity of the dams, and potential cultural landscapes in the immediate vicinity of either or both of the dams. For instance, the bedrock of the rock abutment where the diversion channel to drain Lake Aldwell would be placed is culturally important to the Lower Elwha Klallam Tribe. According to stipulations of the programmatic agreement, the National Park Service would survey the sites prior to construction and seek to avoid areas where sites are identified. If impossible to avoid the sites, the National Park Service would develop mitigation in consultation with the State Historic Preservation Officer and Lower Elwha Klallam Tribe. Without mitigation, uncovering or destroying sites during construction could have major, significant impacts. With mitigation and avoidance, impacts would be minimized as much as possible (see table 59) and are expected to be minor.

Disposal. There is some small chance that disposing of concrete and other fill could bury historic properties (archeological sites), a cultural landscape, or a culturally sensitive area, although disposal sites identified to date are primarily surface mines where it is unlikely any cultural resources remain intact. Surveys of the sites would be undertaken prior to any disposal activities. If important resources were identified, mitigation and monitoring would be required under the programmatic agreement. Impacts would be permanent but expected to be minor.

Construction of Access Roads and Staging Areas. Construction of access roads and staging areas and widening of a portion of Olympic Hot Springs Road, depending on location, could intrude on the structures in Elwha Ranger Station Historic District, Altaire and Elwha Campgrounds' Civilian Conservation Corps kitchen shelters, known and potential landscapes, culturally sensitive areas, and known and unknown archeological sites. Loss of these properties which reflect the ethnic diversity of the Elwha River valley would be considered a moderate impact. In some cases, for instance cultural landscapes, the impact would last only for the two year construction period. For others, such as uncovering resources now protected by being buried, the impact would be permanent but minor, as avoidance through rerouting or mitigation would be required. According to the programmatic agreement, all areas potentially affected would be surveyed by the park service, and appropriate mitigation prescribed before action is taken.

Increased Flooding and Erosion. Removal of Elwha and Glines Canyon dams would result in the frequency of flooding in both the short and long-term, as well as a wider meander path in some places.

There is a small chance that this could result in damage or loss of resources in tribal culturally sensitive areas, including those located in the areas of Little River, Indian Creek, and in the lower Elwha River: cemeteries, villages, homesteads, fishing, spiritual sites, and others significant to the spiritual and cultural lives of the Lower Elwha Klallam Tribe. Known historic buildings and structures, potential cultural landscapes, the Elwha Ranger Station Historic District (particularly the maintenance and storage facilities closer to the river), Forest Service structures farther upslope, and the Altaire and Elwha Campgrounds' Civilian Conservation Corps kitchen shelters could also be affected.

Fifteen known archeological sites in the lower valley including former homesteads of both Elwha Klallam and Euro-Americans, remains of the Milwaukee Railroad, later used by the Spruce Production Division Railroad, a historic artifact scatter, and a cabin site thought to date from Euro-American exploration in the nineteenth century could be subject to erosion or flooding. Undiscovered resources could be subject to erosion and damage.

Those cultural resources at particular risk from flooding or erosion from the river following dam removal are those built or created close in time to construction of Elwha Dam (1910). Other, older sites in the floodplain are not as likely to be affected by dam removal, as they existed under pre-dam conditions.

Monitoring would be a key component of any mitigation plan. If mitigation were not possible, the loss or damage of sites not previously affected by flooding or erosion could occur. The programmatic agreement calls for surveys, a response plan, and bank stabilization or data recovery.

As sediment moves downstream, there is a remote chance it may stall when flows create a sediment wedge and dam river water for a short period of time. If this occurs, little known riverine sites 4,000 to 6,000 years old which may lie on higher terraces not normally affected under current or natural river transport conditions could be eroded or lost. Sediment modeling conducted by the US Bureau of Reclamation does not predict any such short-term damming by released sediment.

Permanent loss of important historic structures, should it occur as a result of increased erosion or flooding, would be a major adverse impact. Mitigation developed according to stipulations in the programmatic agreement would require surveys, establishment of a long-term monitoring program, and bank stabilization or data recovery. With monitoring and mitigation, impacts would be minor.

Cumulative Impacts

A number of cultural resources on the Olympic Peninsula have been lost to development and other actions in the past. Removal of Elwha and Glines Canyon dams and impacts to other historic buildings and structures, archeological sites and cultural sites would result in additional property loss. Documenting these resources according to stipulations of the programmatic agreement would contribute to preservation of their historical significance and knowledge.

The Lower Elwha Klallam have endured threats to their cultural and spiritual lives that included prohibitions on traditional religious practices, loss of access to spiritual sites, and loss of salmon runs vital to their economic, spiritual and cultural well-being. Removal of Elwha and Glines Canyon dams and restoration of the Elwha River ecosystem would allow the Lower Elwha Klallam access to areas with important spiritual sites and would restore their spiritual and cultural relationship with the river.

Conclusion

A free-flowing Elwha River and native salmon fisheries are central to the cultural and spiritual lives of the Lower Elwha Klallam. Removal of the dams would restore a spiritual and cultural relationship significantly affected nearly a century ago when Elwha Dam was built and may uncover important tribal cultural resources. Although there would be adverse short-term effects of dam removal to the tribe, it is willing to accept them in return for these long-term major beneficial impacts.

> ***Although there would be adverse short-term effects of dam removal to the tribe, it is willing to accept them in return for these long-term major beneficial impacts.***

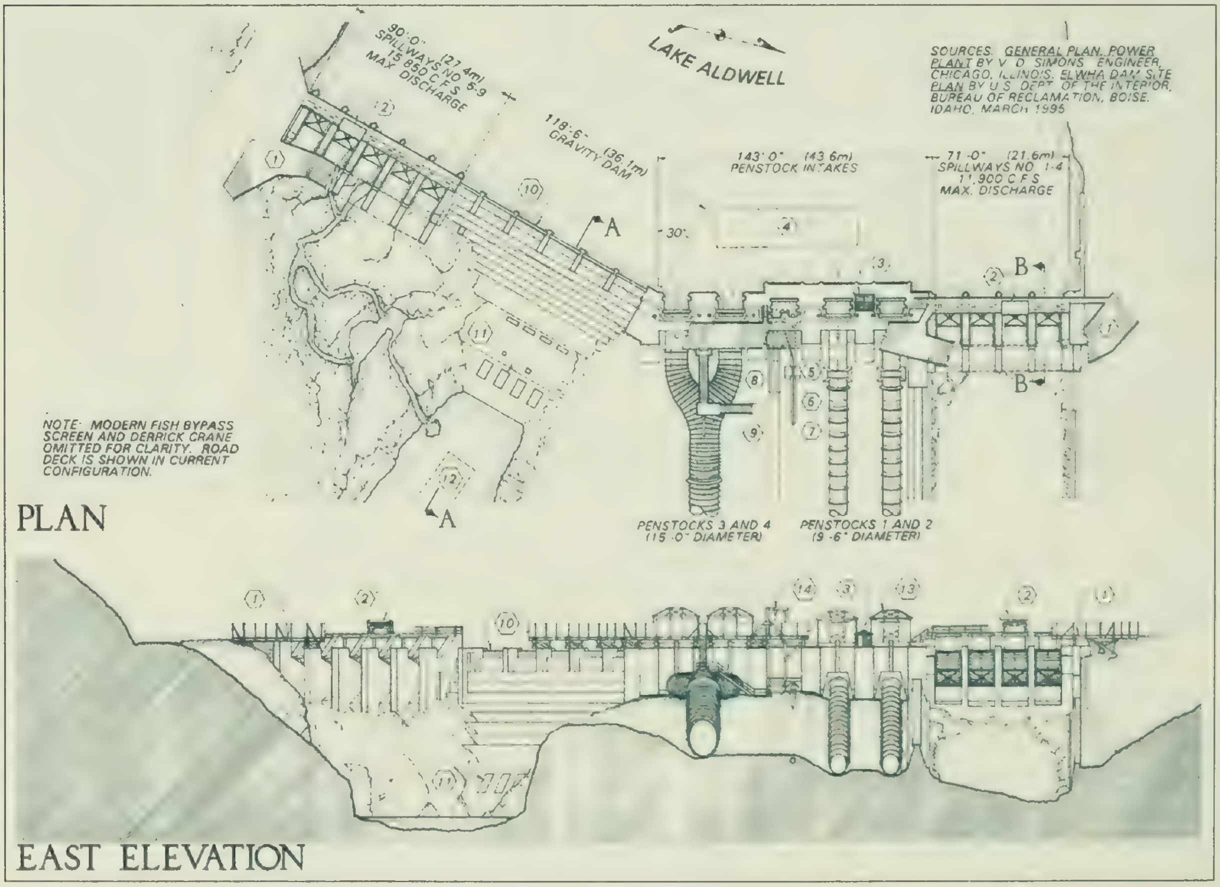
The loss of the Elwha and Glines Canyon dams would be a major one, as the projects are historically important enough to be listed on the National Register. Other historically important structures possibly threatened by either increased flood stage as a result of dam removal, or by road widening and staging associated with construction include parts of the structures at the Elwha Ranger Station and the Civilian Conservation Corps kitchen shelters at Altaire and Elwha Campgrounds. Known archeological sites also could suffer adverse impacts as a result of increased flood stage. There is also some small chance cultural resources could be affected by disposal of dam rubble.

While implementation of the proposal would result in the loss of Elwha and Glines Canyon dams and possibly other resources, a June 6, 1995, programmatic agreement establishes a process for the treatment of cultural resources that includes surveys, identification, evaluation and, if necessary, protection. This process ensures that the significance of the resources would be preserved, although the resources themselves would be lost. Since these measures are required by the National Historic Preservation Act, they are built into the action alternatives, and impacts to all cultural resources would be minor.

Impacts of the Dredge and Slurry Alternative

Impacts from dam removal and associated activities, flooding resulting from sediment moving down the river, and restoration of natural transport would be the same as for proposed action.

Dredging of lake bed sediments could damage cultural sites, archeological sites, and potential cultural landscapes of concern to the Lower Elwha Klallam people. Construction for the slurry pipeline could, depending upon location, damage or impact any of three known historic structures/ districts (Elwha Ranger Station, Elwha Campground kitchen shelter, and Altaire Campground kitchen shelter), known and potential cultural landscapes, archeological sites and sites of special concern to the Lower Elwha Klallam. According to stipulations of the June 6, 1995, programmatic agreement, the road and proposed pipeline route would be surveyed and any resources identified. Every effort would be made to avoid resources through design. Should that be impossible, mitigative measures that could include documentation and/ or data recovery would be developed in consultation with the State Historic Preservation Officer and Lower Elwha Klallam Tribe.


90'-0" (27.4m)
SPILLWAYS NO 5-9
15 850 C F S
MAX DISCHARGE
LAKE ALDWELL
SOURCES. GENERAL PLAN, POWER PLANT BY V D SIMONS ENGINEER, CHICAGO, ILLINOIS. ELWHA DAM SITE PLAN BY U S DEPT OF THE INTERIOR, BUREAU OF RECLAMATION, BOISE. IDAHO, MARCH 1995
118'-6" (36.1m)
GRAVITY DAM
143' 0" (43 6m)
PENSTOCK INTAKES
71'-0" (21.6m)
SPILLWAYS NO 1-4
11,900 C F S
MAX. DISCHARGE
A
B
30'
NOTE: MODERN FISH BYPASS SCREEN AND DERRICK CRANE OMITTED FOR CLARITY. ROAD DECK IS SHOWN IN CURRENT CONFIGURATION.
PLAN
PENSTOCKS 3 AND 4 (15'-0" DIAMETER)
PENSTOCKS 1 AND 2 (9'-6" DIAMETER)
EAST ELEVATION
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Historical American Engineering Record drawing (draft, 1995) showing plan and section of Elwha Dam. (Olympic National Park, Peter Mattson drawing)

Conclusion

Additional impacts to cultural resources are possible from trenching to bury the pipeline, laying the pipeline above ground, or from the use of dredges. Impacts would be either avoided through design or resources documented or recovered as required by the National Historic Preservation Act. Because of this required mitigation, impacts would be minor.

Socioeconomics

Summary of Regulations and Policies

The National Environmental Policy Act (NEPA) requires analysis of social and economic impacts resulting from proposed major federal actions. In addition, Executive Order 12898, dated February 11, 1994 on "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires federal agencies to assess the impact of actions on minority and low-income communities. Although there are no specific regulations requiring protection of social values, impacts to them must be fully analyzed and considered in federal planning processes.

Methodologies for Analyzing Impacts

The methods used to assess economic effects of the proposed action and alternatives include defining a project period of 100 years; estimating impacts over a range of discount rates from 0 to 7% (see glossary for definition of "discount rates") and following Office of Management and Budget (1992) recommendations to use real rather than nominal values in economic analysis. Use of real prices and rates removes inflation from all calculations, but accounts for price changes caused by fluctuations in demand and supply. After consultation with the Bonneville Power Administration, revised assumptions were used of expected real prices for future energy purchases from the coal-based estimates used by the Federal Energy Regulatory Commission in its analysis of the Elwha project. Data and assumptions underlying principal economic findings are contained in "Elwha River Restoration Project — Economic Analysis" (Meyer et al. 1995) and in an update of that analysis (Meyer 1995).

Social impact assessment addresses a wide variety of concerns, ranging from jobs and housing to rural development and facility siting, all of which affect social aspects of community life. Social impact assessment is closely tied to the assessment of economic impacts, although different methods are used to evaluate effects. For the majority of projects, it is employment and its impact that initiate a chain of social effects. Increases or reductions in jobs and spending lead to population changes, which in turn affect housing, social services, and community well-being.

Impacts of No Action

County Economic Base

Commercial and recreational fishing have traditionally been a cornerstone of the Clallam County economy. Construction of Elwha Dam in 1910 resulted in an immediate and significant decline in salmon and trout, and continued operation of Elwha and Glines Dams has resulted in lower income and higher unemployment for these employment sectors. Recently, employment in the timber sector has also declined in the area, exacerbating regional economic difficulties.

Infrastructure, Services and Utilities

As a result of the hydroelectric projects, the county collects $230,000 annually in property taxes. This would continue to be a source of revenue if the dams remain.

Under the No Action alternative, rapid demographic changes are not projected; however, the transition from extraction and harvest to tourism and service-based industries would be gradual and lessen any acute changes in social conditions.

Power Production for the Daishowa Mill

Under the No Action alternative, the cost of producing power at the two dams would would rise to about $2.1 million annually. If the dams were removed, this would increase to about $4 million. An additional $8.7 million in repair costs are expected in the near future (FERC 1993 p. 2-19) if the dams remain.

Fish and Fish Processing

An estimated $840,000 in business benefits are generated to all fishing sectors in a recent average year (table 60).

Income, Employment and Poverty

Existing income, employment and poverty statistics are provided in the Affected Environment section. Under the No Action alternative, higher than state average unemployment and poverty and lower than state average income would likely continue.

Social Values

Clallam County. Clallam County is moving toward employment increases in tourism, retirement and service-based jobs, and away from resource-based activities, such as lumber or fish harvesting. The impact the dams have had on salmon and steelhead in the Elwha River may have contributed to the decline of commercial or sport fishing locally.

Table 60. *Estimated Annual Net Business Benefits from Elwha Fish*

SPECIES	FISHERIES TYPE	NO ACTION (millions of dollars)
Chinook	Commercial Non-tribe	0.09
	Commercial Tribal	0.38
	Sport Business	0.09
Coho	Commercial Non-Tribe	0.05
	Commercial Tribal	0.11
	Sport Business	0.05
Steelhead	Commercial Tribal	0.05
	Sport Business	0.02
Total Annual Benefits		**0.84**

Lower Elwha Klallam Tribe. Construction of Elwha and Glines Dams also preempted treaty fish resources secured to the Elwha Klallam, Port Gamble Klallam, Jamestown S'Klallam and Makah tribes in 1855. This preemption has combined with very limited access to alternative economic opportunities to leave Lower Elwha Klallam people today as the most economically disadvantaged group in Clallam County (see table 23). For example, tribal unemployment stands at 35%, and rises to as high as 80% in some months.

The tribe considers the fishery potential of the Elwha River its most significant economic asset, and operates a hatchery for chinook, coho and steelhead yielding 71,500 pounds of fish in 1987. Most tribal fishers presently rely on fish produced by this hatchery to some degree to obtain a relatively small amount of income and/or food each year.

Conclusion

There would be no additional costs or benefits over existing conditions, except for the $8.7 million in required repair costs, if the dams were not removed. Clallam County would continue to receive $230,000 in property taxes, and the Daishowa mill would pay an estimated $2.1 million per year for the portion of power it receives from the hydroelectric projects. Business benefits from fisheries would continue at $840,000 per year. Under the No Action alternative, major adverse economic impacts would continue for the Lower Elwha Klallam Tribe.

Impacts of the Proposed Action – River Erosion Alternative

County Economic Base

Elwha River restoration activities would have specific economic effects on the economy of Clallam County. After restoration was complete, 446 annual jobs and a payroll of $4.6 million would be generated in the Clallam County recreation and tourism sector, increasing local sales taxes by $296,000 per year. It is estimated that present construction cost projections of between $111.1 million and $127.4 million will generate between $60 and $65 million in business activity in Clallam County over the 10-year construction period and an additional $32-$34 million in personal income. An estimated total of between 1,150 and 1,240 jobs would also be generated over the 10-year construction period (Meyer 1995); poverty in Clallam County would be reduced accordingly. Construction workforce would peak at 450 workers in the second year of operation.

Dam removal, regardless of the sediment management alternative chosen, would reduce county property tax revenue by $230,000 per year and increase revenue to the local power utility by $440,000 per year. Local share of state sales tax would increase by $296,000 per year after project completion.

Infrastructure, Services and Utilities

Removal of both dams would restore natural sediment processes in the entire river and into the marine area. It would increase natural sediment available to Ediz Hook, reducing maintenance costs by an estimated $28,000 per year. Water quality and flood protection measures are described in the Impacts sections of this EIS and would be a long-term major benefit of the proposed action.

There would be a short-term increase in workers and service providers in Clallam County for up to 10 years as a result of dam removal. It is estimated that a total of between 1,150 and 1,240 workers would be required during pre-construction, construction and post-construction phases, and that the construction workforce would peak at 450 workers. At this time, vacancy rate in Port Angeles is 9% of 25,225 units, or 2,270 units vacant. Even if they come from outside the region, all workers could be accommodated by occupying these vacant units. No measurable change of public infrastructure would be needed to service the short-term construction workforce and associated population.

Power Production for Daishowa Mill

Dam removal, regardless of the method of sediment management, would require Daishowa mill to absorb additional costs for the portion of the 172 gigawatt-hours of power it would lose, relative to the No Action alternative. The real cost per year of providing power, expressed in 1996 dollars, is provided in table 61. Daishowa would pay between 26.7 mills and 23.0 mills for replacement power, based upon Bonneville Power Administration energy

Table 61. *Estimated Annual Real Energy Cost for Replacement Power for Daishowa Mill*
(172 Gwh; $ million per year in 1996 dollars)

	1997	2000	2010
No Action	2.1	2.1	2.1
Remove both dams	4.3	3.9	4.0

supply costs. This compares to 12.3 mills under No Action. These rates are calculated based on Bonneville Power Administration energy supply costs.

Over the 100-year period, additional regional cost for replacement power would total $73.7 million (assuming a 3% discount rate). The impact of this increase on the average consumer's electric energy bill would be negligible.

Fisheries and Fish Processing

Annual net business benefits from fisheries restoration after dam removal would slowly increase and eventually reach $1.1 million, regardless of the sediment management alternative (see table 62). Annual net economic benefits to business from fishery restoration are summarized for dam removal (either alternative) and No Action in table 62.

As table 62 shows, net economic benefits to commercial and sport fish business sectors would reach $3.5 million per year if the dams are removed. Over the 100 years following dam removal, additional fisheries benefits (discounted at 3%) would total $34.6 million, expressed in present value terms.

Elwha Resort on Highway 101 at Olympic Hot Springs Road.
(Curtis Miller photo)

Table 62. *Estimated Annual Net Business from Elwha Fish Restoration — After Completion of Fisheries Rebuilding*

SPECIES	FISHERIES TYPE	NO ACTION	REMOVE BOTH DAMS
		(millions of dollars)	
Chinook	Commercial Non-Tribe	0.09	0.25
	Commercial Tribal	0.38	1.06
	Sport Business	0.09	0.24
Coho	Commercial Non-Tribe	0.05	0.16
	Commercial Tribal	0.11	0.38
	Sport Business	0.05	0.16
Pink	Commercial Non-Tribe	—	0.29
	Commercial Tribal	—	0.32
	Sport Business		0.07
Chum	Commercial		0.13
	Non-Tribe Commercial		0.15
Sockeye	Commercial Non-Tribe	—	0.03
	Commercial Tribal	—	0.04
Steelhead	Commercial Tribal	0.05	0.10
	Sport Business	0.02	0.05
Total Annual Benefits		**0.84**	**3.46**

Recreation/Tourism

With the Elwha River restored, an estimated increase of 734,000 annual visitor nights is projected for Clallam County, generating additional business expenditures by visitor/tourists of $28.5 million per year in Clallam County, and business profits of $5.7 million per year (Meyer et al 1995). Over the 100 years following dam removal, additional recreation and tourism benefits (discounted at 3%) would total $134 million, expressed in present value terms.

Social Values

Clallam County. Over the long term, removal of the dams would provide for greater overall economic stability in the area when added to the cumulative economic changes the county is now experiencing.

Restoration of the ecosystem over the long term is consistent with the projected goals in Clallam County — moving toward sustainable sources of economic growth, tourism and service based industries. Removal of both dams would provide short-term economic impetus for recovery due to the construction project, and long-term additions to business revenue, personal income, and local tax revenue from recreation and tourism. This alternative would also provide needed long-term stimulus to tribal and non-tribal commercial fishing sectors and to businesses based on sport fishing. Members of the tribe would experience significant increased opportunities for income, restored cultural practices related to the river, and renewed optimism about the future of the Lower Elwha Klallam tribal people.

Lower Elwha Klallam Tribe. Removal of the two dams would return fishery resources secured to the Elwha Klallam people under the terms of the Point No Point Treaty. Restoration of the fisheries would have major beneficial effects upon presently adverse levels of tribal employment, income, health. Removal of the dams would restore access to culturally sensitive sites considered by the Lower Elwha Klallam to be vital to their spiritual well-being.

Nonmarket Values. Removal of both dams would result in major nonmarket benefits (those benefits a buyer associates with a product, service or activity over and above what is paid for it). For instance, sport fishers attach a benefit to the recreational pleasure associated with catching a fish which exceeds the cost they incur in catching it.

The nonmarket value of fully restoring the Elwha River ecosystem and native anadromous fisheries was assessed in a 1995 study by Dr. John Loomis of Colorado State University. This value measures what citizens of the United States would be willing to pay in increased federal taxes over a 10 year period to fully restore the river — even if they did not plan to visit the area personally. This estimate was based on a consultant survey of over 300 residents of Clallam County and more than 1,300 U.S. citizens in total. Averaging responses, and assuming that persons who did not return the survey would pay nothing, the

Table 63. *Summary of the Net Present Value of Elwha River Restoration Market Benefits over Project Life — at 3% Discount Rate*

MARKET BENEFITS	BOTH DAMS REMOVED (millions of dollars)
Commercial Fisheries (Tribal & Non-tribal)	30.1
Sport Fish Business	4.5
Ediz Hook	0.9
Recreation and Tourism	132.6
Total Market Benefits	**163.6**[a]

[a] Excludes sport fish business net revenue to avoid double counting

total nonmarket value of restoring the Elwha River native anadromous fisheries and ecosystem was estimated to be $3.5 billion annually for 10 years. (Loomis 1995).

Although the study of nonmarket values was developed and conducted carefully and conservatively, data underlying nonmarket estimates of value may be more variable than market estimates. To put them in perspective, the study team calculated how far "off" the estimated $3.5 billion nonmarket value would have to be to invalidate the conclusion that the benefits of dam removal outweigh costs (i.e., that the benefit/cost ratio was smaller than one). They found that even crediting minuscule proportions (one-half of one percent) of the nonmarket benefits reported by Loomis would yield a positive benefit-cost ratio under all discounting scenarios.

Total benefits of dam removal greatly exceed total costs.

Net Economic Value of Project

The present net economic value (the total present value for a 100-year period) measures the net change from the No Action option of benefits and costs associated with removal of both dams, calculated over 100 years and discounted at 3 percent. Estimated comparative business benefits and project costs are summed and displayed on this basis as single present dollar totals in tables 61 and 62. For the proposed action, benefits from increased recreation and tourism would amount to $133 million over the life (100 years) of the project. The $3.5 million per year of net economic benefits from restoring fish stocks would amount to $35 million over the 100-year project life (and discounted at 3%).

Cost of removing both dams is itemized in the Alternatives section of the EIS.

Cumulative Impacts

Clallam County is in transition. Rural in nature, lumber and fish dependent for most of its history, the county is now experiencing declines in its traditional resource-based activities, particularly in the Port Angeles to Forks Highway 101 corridor. In addition, the county is experiencing fairly rapid change due to increases in tourism, retirement settlement, and service-based jobs, notably from its eastern boundary at Sequim westward to the city of Port Angeles. The decline of the salmon fishery as a result of the Elwha River dams has added to the trend away from an economy based on sustainable harvest of natural resources.

Conclusion

Total benefits of dam removal greatly exceed total costs. Business benefits associated with recreation and tourism, including sport fishing, would total $133 million over 100 years of project life, at 3% rate of discount (see table 63). Commercial fishing and sport fishing businesses would obtain $3.5 million per year of net economic benefits after fish stocks were restored, amounting to $35 million over project life. Approximately $1 million over the life of the project would be saved in erosion control costs at Ediz Hook, and the shellfish harvest would be more productive.

Activity associated with removal of both dams would generate between 1,150 and 1,240 jobs in Clallam County, $32–34 million of personal income, and between $60 and $65 million in business activity in Clallam County over the 10-year period of river restoration activity. After restoration was complete, 446 jobs and a payroll of $4.6 million would be generated in the Clallam County recreation and tourism sector, increasing local sales taxes by $296,000 per year.

The estimated cost of implementing the proposed action is $111.1 million, although further refining of costs and increased certainty of costs may reduce this figure. Under both action alternatives, property tax would decline by $230,000, while payments to the local energy utility would increase by $440,000. Only dam removal is consistent with federal trust responsibilities to the four affected Indian tribes or would substantially reduce material and cultural damages suffered by the Lower Elwha Klallam Tribe as a result of construction of the dams.

Increases in the employment workforce can be accommodated by the regional area and are not expected to generate any significant changes in need for public services. Over the long term, significant economic benefits would be realized by removal of both dams. This would contribute to the overall well-being of the county and region. The tribe would realize significant benefits over the long term both economically, culturally, and therefore, socially.

Impacts of the Dredge and Slurry Alternative

The economic benefits are essentially the same between the proposed action and the Dredge and Slurry alternative. The estimated cost of implementing the Dredge and Slurry alternative is $127.4 million. The pipeline would add between $16.9 and $21.1 million, depending on alignment (the more expensive alignment is assumed in forecasting costs), but water quality treatment costs would be lower. This difference in cost, however, would not alter the socioeconomic characteristics of the local or regional area beyond that described for the proposed action.

Conclusion

The socioeconomic impacts of this alternative are very similar to the proposed action, except that the capital costs are higher by $16.3 million overall.

Penstock at Elwha Dam. (Charles Scott photo)

Public Health and Safety

Earthquakes

Summary of Regulations and Policies

The 1988 *National Park Service Management Policies* state that..."the saving of human life will take precedence over all other management actions. The National Park Service...will seek to provide a safe and healthful environment for visitors and employees..." The *Policies* also require that an emergency action plan be prepared for all dams within park boundaries. This program emphasizes visitor and employee safety and the protection of property in the event of dam failures and includes a systematic method for alerting visitors to potential disasters and evacuation procedures. For more information on the emergency action plans for Glines Canyon Dam refer to the Affected Environment chapter, Dam Safety section.

Methodologies for Analyzing Impacts

In order to assess the potential impacts on visitors, park employees, and structures, a literature search was conducted on the earthquake hazards of the Olympic Peninsula. Staffs at the Washington Department of Natural Resources, Washington Department of Ecology, US Geological Survey, US Bureau of Reclamation-Seismotectonics Branch, and Federal Energy Regulatory Commission were also queried about the possible risks and impacts of earthquakes.

Impacts of No Action

Seismic activity on the Cascadia Subduction zone in northwestern Washington has been determined to be three different types: deep earthquakes occurring within the descending Juan de Fuca plate, shallow crustal events within the North American plate, and postulated great megathrust earthquakes (magnitude 8 to 9.5) along the plate interface (Yelin et al. 1994). Research indicates that the last great earthquake occurred approximately 300 years ago and that the average recurrence interval is on the order of 500 years (Adams 1990; Atwater 1987). See Affected Environment chapter, Earthquakes section for more information.

Sources (Ludwin et al. 1991) say future deep earthquakes up to magnitude 7.5 could occur in the Puget Sound area, although it is uncertain whether this magnitude earthquake could occur on the Olympic Peninsula. Recent research suggests that larger shallow crustal earthquakes (up to magnitude 7 to 7.5) with associated surface rupture could cause potential seismic hazards in the region (Bucknam et al. 1992). There also is the possibility of a large megathrust earthquake, with magnitudes to 8.5–9.0 and an average recurrence interval of 500 years. The recurrence interval of deep subduction zone and shallow crustal earthquakes in the area is unknown.

Glines Canyon Dam has been rated safe by the Federal Energy Regulatory Commission and the state of Washington for the existing maximum credible earthquake, but the safety of Elwha Dam is unknown. The lack of a recent comprehensive safety evaluation prevents a complete assessment of engineering state-of-the-art standards of the dams at this time. Recent seismic research in the area may require updating the maximum credible earthquake values, revising dam safety standards, reinspecting the dams and reevaluating their safety under the new criteria.

The Lower Elwha Klallam Tribe considers any risk of dam failure from seismic occurrences unacceptable. Although the frequency of 1/500 or .2% (.020) associated with a "great earthquake" is relatively low, the catastrophic harm such a quake would make it a significant risk to life and property on the reservation.

Conclusion

Glines Canyon Dam has been rated safe by the Federal Energy Regulatory Commission and the state of Washington for the existing maximum credible earthquake, but the safety of Elwha Dam is unknown. Uncertainties about the location of recently discovered faults suggest that the maximum credible earthquake rating may need to be reevaluated. Until the reevaluation is complete, the safety risks associated with a large magnitude earthquake exceeding the maximum credible earthquake is unknown at both dams. If larger maximum credible earthquake standards are developed, dam safety would be reanalyzed and modifications made to the structures if necessary.

Impacts of the Proposed Action – River Erosion Alternative

Both Elwha and Glines Canyon dams are classified as having high hazard potential because of the possible loss of life and property downstream in the event of their failures due to an event exceeding the current maximum credible earthquake or probable maximum flood (DOI 1995). When the reservoirs are drawn down, the load on the structures would be reduced, in turn reducing the potential of a catastrophic flood if an earthquake exceeding the maximum credible earthquake were to occur during dam removal.

Although it is not possible to precisely predict the occurrence of an earthquake, a large magnitude, damaging earthquake is unlikely during dam removal. Scientists predict that the maximum credible earthquake in Washington would be a subduction-type earthquake with a magnitude on the order of 7.5 on the Richter scale. Research indicates that the last great earthquake occurred approximately 300 years ago and that the average recurrence interval is approximately 500 years (Adams 1990; Atwater 1987). See Earthquakes Affected Environment.

Although unlikely during dam removal, earthquake-induced flooding caused by dam failure or a seiche wave (water spilling over the dams caused by an earthquake) would be eliminated after removal — a beneficial impact on public health and safety for all those downstream.

Cumulative Impacts

The threat of a large, damaging earthquake occurring on the Olympic Peninsula continues whether or not the dams are removed.

Conclusion

If dam safety deficiencies are identified, removal would have a beneficial effect on public health and safety by eliminating the danger of flooding caused by dam failure or by water overtopping the dams during a large scale earthquake. Dam removal would also eliminate the need for potential large expenditures to correct deficiencies attributed to the new maximum credible earthquake or probable maximum flood.

Impacts of the Dredge and Slurry Alternative

The impacts of the slurry pipeline alternative would be same as the proposed action.

Conclusion

If dam safety deficiencies are identified, removing the dams would have a beneficial effect on public health and safety, eliminating the danger of flooding caused by dam failure or by water overtopping the dams during a large scale earthquake. Dam removal would also eliminate the need for potential large expenditures to correct deficiencies attributed to the new maximum credible earthquake or probable maximum flood.

Dam Safety

Summary of Regulations and Policies

National Park Service Guideline 40, Dams and Appurtenant Works, Maintenance, Operation and Safety, February 1983, concisely outlines responsibilities for National Park Service personnel in the planning, design, preservation, rehabilitation/construction, maintenance and operation, inspection, acquisition or disposal of dams under Park Service management. *Special Directive 87-4, Dams and Appurtenant Works - Desk Manual for Maintenance, Operation and Safety,* October 1987, is an administrative directive that in conjunction with Guideline 40 directs Park Service personnel in maintenance, operation, and safety actions required for dams and appurtenant works on agency lands.

Operating licenses for the dams are required pursuant to the Federal Power Act, formerly the Federal Water Power Act of 1920; safety is a key factor in determining whether licenses will be issued. Glines Canyon project was issued a 50-year operating license that expired June 3, 1976. Since then, it has been operated under annual licenses. The Elwha project was constructed prior to the act and has not been licensed.

Methodologies for Analyzing Impacts

In anticipation of possible transfer of safety and operating responsibilities of Glines Canyon and Elwha dams to federal ownership, (whether the dams are removed or not), and as required by National Park Service Guideline 40 and Special Directive 87-4, a site visit and a literature review were conducted in September 1994. The inspector documented the current condition of the dams and identified issues of public safety, operation and maintenance. An in-house literature review of current seismic hazards in northwestern Washington was done by National Park Service and Bureau of Reclamation — Seismotectonics Branch staff.

Impacts of No Action

Both Elwha and Glines Canyon dams are classified as having a high hazard potential because of the possible loss of life and property downstream in the event of dam failure (DOI 1995). Inspections during the fall of 1994 (BOR 1995g) found no current or potential safety deficiencies for normal operating conditions at either dam, and determined that Glines Canyon Dam is able to withstand abnormal remote events such as a probable maximum flood or maximum credible earthquake. Elwha Dam, however, may need to be reanalyzed for these extreme loading conditions.

Elwha Dam was originally built on loose river fill material, and the foundation failed in 1912. The possibility of an increased safety risk associated with the dam's substrate remains. To date, there have been no thorough studies assessing the safety of the foundation (including the 1994 inspection by the US Bureau of Reclamation). However, a report by Shannon and Wilson (1968) stated that "even in the event of a major earthquake, there is little likelihood that water would escape catastrophically from the foundation as it did in 1912, provided that the concrete gravity dam remains intact." A report prepared by the Bureau of Reclamation (BOR 1995g) cites no evidence of seepage related safety of dam issues, but did note that past repairs of the dam foundation following the 1912 failure were makeshift and did not meet state-of-the-art procedures and practices.

Elwha Dam received a classification of "fair" based on a safety inspection of the dam in 1994 by the Bureau of Reclamation. The inspection documented current conditions, and looked for safety, operation and maintenance, and public safety issues related to continued operation of the dams. The "fair" rating means no "existing or potential dam safety deficiencies are recognized for normal operating conditions," but that "remotely occurring events" such as those approaching either a probable maximum flood or maximum credible earthquake may "cause a dam deficiency" (BOR 1995g). The author of the inspection report recommends that consideration be given to additional seismotectonic analyses of the dam, and that future analyses of the dam structures make use of up-to-date, site-specific seismotectonic evaluation of loading conditions, including an assessment of the potentially active faults in the area.

As the dams age, they continue to deteriorate, requiring maintenance and upgrading of facilities. Both dams must be inspected yearly to ensure their structural integrity. If licensed in the future, each dam would undergo a comprehensive 12-part inspection of its structures every five years.

Conclusion

If the dams are not removed, potential flooding hazards from events such as a maximum credible earthquake, would continue to exist, particularly at the Elwha Dam. If the dams remain in place, they would require continuing maintenance and upgrading of facilities.

Impacts of the Proposed Action – River Erosion Alternative

The primary safety hazard during dam removal would be from uncontrolled releases of water from the reservoirs. Dam removal designs have incorporated safety measures to prevent uncontrolled releases during dam removal, or to mitigate their impact should they occur. During the initial stages of dam removal, both reservoirs would be drawn down to the lowest elevation possible using existing facilities (spillways and power penstocks). Glines Canyon Dam would remain intact and Lake Mills drained to the maximum extent possible to provide flood storage while workers created the diversion channel for Elwha Dam.

A cofferdam would be placed near the north bank, upstream of Elwha Dam, so that a diversion channel could be constructed through the current location of the north spillway without the river flowing through it. The diversion channel would be used to drain most of Lake Aldwell, and would be sized to pass normal flows and large floods safely through the damsite while other structural features were being removed.

The gunite cap and fill material upstream of Elwha Dam would not be removed until the diversion channel was operational and the reservoir substantially drawn down; this would minimize the risk of foundation washout underneath the gravity section of the dam as occurred during dam construction in 1912. The rate of drawdown of Lake Aldwell would be controlled and conditions monitored to minimize the potential for occurrence of small landslides within the reservoir area.

Glines Canyon Dam would be removed by incrementally notching the arch dam structure at various elevations and lowering the reservoir and dam in stages. When the notches were initially developed, there would be a sudden but moderate increase in water discharge. This "peak" discharge would be noticeable only in the immediate vicinity of the dam and lessen as the flow passed downstream. Lake Mills would drop to a lower elevation and stabilize as the inflow and outflow became balanced. Flows exceeding the capacity of the notches would flow over the top of the dam at the water elevation at that time. The additional flows would not jeopardize the integrity of the remaining section of the dam.

Provisions for public safety, such as fencing, guardrails, and warning signs, would be required around the remaining structures on both abutments at Glines Canyon Dam. Removing the dams would eliminate any safety risks they now pose for downstream residents and property.

Cumulative Impacts

Since the dams are operated in a run-of-the-river mode, there is a normal threat of flooding during high runoff periods. Potential damage to the dams from a large earthquake is reduced as the load on the structures is lessened during the dam removal stages.

Conclusion

Safety precautions have been built into the dam removal designs to minimize the threat of flooding, and to ensure worker and visitor safety during dam removal. Because of these measures, no adverse effects on public health or safety from dam removal would be anticipated. Removing the dams would eliminate any safety risk they now pose for downstream residents and property.

Impacts of the Dredge and Slurry Alternative

Impacts of the Dredge and Slurry alternative would be the same as the proposed action since the dam removal designs are the same for both action alternatives.

Conclusion

Safety precautions have been built into the dam removal designs to minimize the threat of flooding, and to ensure worker and visitor safety during dam removal activities. Because of these measures, no adverse effects on public health or safety from dam removal are anticipated. Removing the dams would eliminate any potential risk they now pose for downstream residents and property.

Hazardous Materials

Summary of Regulations and Policies

National Park Service Management Policies, 1988, require park managers to "...take actions to address existing hazardous waste problems such as buried toxic dumps and landfills, spills, and contamination of water, soil, and air." When acquiring future park sites, potential hazardous waste problems will be included in the site evaluation/acquisition process and will be brought to the attention to the director as soon as they are identified (NPS 1988a).

Executive Order 12088, Federal Compliance with Pollution Control Standards, 1978, assigns responsibility for environmental requirements for hazardous materials in facilities and programs to the heads of executive agencies. It also requires that all necessary actions are taken for the prevention, control, and abatement of environmental pollution.

The Resource Conservation and Recovery Act of 1976 is cradle-to-grave legislation governing the generation, transportation, treatment, storage, and disposal of current and future hazardous and solid wastes and underground storage tanks. Federal agencies are subject to all federal, state, and local hazardous waste requirements. Washington State has been delegated authority from the federal government to implement and enforce its own toxic waste program through the Washington Model Toxics Control Act.

Workers responsible for the clean up of hazardous wastes for this project would be protected by the Occupational Safety and Health Act that requires a safety and health work plan, emergency response program, record keeping, training, use of personal protective equipment, and medical surveillance.

Methodologies for Analyzing Impacts

To determine the amount of hazardous contamination in the project area, particularly at the two damsites, the US Fish and Wildlife Service and Bureau of Reclamation conducted a reconnaissance level 1 pre-acquisition environmental containment survey in February 1993. A more detailed level 2 survey was undertaken in May 1994 at the Glines Canyon switchyard area. Soil samples were collected and tested for pesticides, polychlorinated biphenyls, and total petroleum hydrocarbons (PCBs). Detailed information on the results of the survey can be found in the summary reports prepared by the Fish and Wildlife Service (FWS 1995a, b).

Impacts of No Action

A team of hazardous material experts from the Bureau of Reclamation and US Fish and Wildlife Service conducted a reconnaissance level (level 1) pre-acquisition environmental containment survey of both dams and accompanying facilities in February 1993. Since the dams were built in the early 1900s, the team particularly searched for asbestos and lead-based paint in the building materials and polychlorinated biphenyls (PCBs) in the transformers, capacitors, and other electrical components. The survey identified: solid wastes at a quarry dump; household debris at private residences at the Elwha Resort; underground storage tanks at the Elwha Resort; chemicals such as fuel, paints, lubricants, and pesticides at various storage facilities and equipment repair areas at both damsites; asbestos covered wiring at both dams; oil-stained ground from leaking transformers at Glines Canyon Dam; pole and pad mounted transformers at both facilities; and banks of batteries at both powerhouses (FWS 1995a). Testing for lead-based paints was not done although, given the age of the structures, they are likely to be present.

Since oil-contaminated soils containing PCBs were found in the Glines Canyon switchyard area during the level 1 survey, a more detailed, level 2 survey was conducted on May 18-19, 1994. During that survey, 15 soil samples were taken from the Glines Canyon switchyard area and one sample was collected from the base of the power pole just outside the fence of the Elwha power plant storage yard. All samples were tested for the presence of organochlorine pesticides, total PCBs, and total petroleum hydrocarbons. Organochlorine pesticides were detected in traces to low concentrations in 3 of the 15 samples (FWS 1995b). Concentrations of these compounds were below the industrial clean-up level of 5.0 parts per million required by the Washington Model Toxics Control Act. One sample contained low levels of PCBs, .626 parts per million, also less than the required state clean-up level of 1.0. Total petroleum hydrocarbons exceeded the state allowable limit of 200 parts per million at 11 of the 15 sites, and would require clean up to comply with state standards. This area will be remediated by removal of concrete, transformers, and soils down to the deepest detected contamination.

Capacitors and oil-filled electrical bushings have not been tested for the presence of PCBs. If testing indicates their presence, the bushings would be disposed of as hazardous materials. Hazardous waste disposal cost estimates for this project are based on the presumption that PCBs are present.

Inspection team members also found asbestos in the exterior siding of the Elwha Dam office, in the floor tile, interior wall plaster, and electrical wiring insulation of the Glines Canyon Dam residence, and throughout electric cable insulation in both powerhouses during the level 2 survey (FWS 1995b).

Conclusion

Hazardous materials (asbestos, lead-based paints and PCBs) found at the hydroelectric projects at both damsites would remain should the No Action alternative be selected. The aging transformers are leaking; these and other features would need to be maintained, replaced or removed to prevent further contamination of the damsites. Total petroleum hydrocarbons exceeding the state allowable limit would also need to be remediated.

Impacts of the Proposed Action – River Erosion Alternative

During dam removal, all hazardous materials would be remediated or transported off site prior to awarding the demolition contract, pursuant to all applicable federal and state laws. Project mitigation for hazardous wastes in the project vicinity is mandatory and includes the clean up or remediation of petroleum-contaminated soils in the Glines Canyon Dam switchyard; underground storage tanks at the Elwha Resort; asbestos-containing materials at various project facilities including the switchyard, power plant and residences; and the disposal or recycling of chemical stores including fuels, lubricants, paints, pesticides, and batteries. With proper containment and remediation techniques, no hazardous materials would enter the river during dam removal.

Construction equipment on the damsite could leak oil or require refueling at the site, possibly resulting in minor amounts of oil or diesel fuel entering the reservoirs or water. Air emissions would be increased during operation of construction equipment. These discharges and emissions would not exceed standards set by the Clean Water Act or the Clean Air Act.

Cumulative Impacts

Although no other sources of hazardous materials are known in the Elwha River corridor, there is the possibility of leaking buried storage tanks and other hazardous materials in the lower floodplain that have not yet been identified.

Conclusion

Hazardous materials in the project area, primarily at the damsites, including petroleum contaminated soils, underground storage tanks, asbestos containing materials, lead-based paint and various chemical stores would be remediated and transported to an approved disposal site. Removal of these materials from the Elwha watershed would reduce the hazardous wastes in the area and lessen the chance of further contamination of soils, air, and water by these pollutants.

Impacts of the Dredge and Slurry Alternative

Remediation of hazardous materials would not differ between the two action alternatives; the impacts of the Dredge and Slurry alternative would be the same as the proposed action. Hazardous materials in the project area, primarily at the damsites, would be remediated and transported to an approved disposal site. Removal of these materials from the Elwha watershed would eliminate known sources of hazardous wastes and further contamination of soils, air, and water by these pollutants.

Conclusion

Hazardous materials in the project area, primarily at the damsites, including petroleum contaminated soils, underground storage tanks, asbestos containing materials, lead-based paint and various chemical stores would be remediated and transported to an approved disposal site. Removal of these materials from the Elwha watershed would reduce the hazardous wastes in the area and lessen the chance of further contamination of soils, air, and water by these pollutants.

Traffic

Summary of Regulations and Policies

There are few specific regulations on the use of roads. Some, such as Laird Road, Edgewood Drive, and Lower Elwha Valley Road are weight restricted; permits from Clallam County, Washington State Department of Transportation or the National Park Service must be obtained for heavy trucks to use them.

Methodologies for Analyzing Impacts

Traffic would be generated by trucks carrying equipment and personnel to the sites, and the same plus dam rubble, fill material and other waste from the sites. Nine disposal locations were analyzed, and 13 major intersections between the damsites and those locations evaluated for impacts on traffic.

Intersection operating conditions were evaluated using the *Highway Capacity Manual Third Edition*, updated 1994, and 1994 *Highway Capacity Software* for intersections with and without signals.

The No Action Alternative and Existing (1995) Conditions:

Impacts from the project were studied for the peak hour of traffic in the summer peak season two different possible construction years to determine the worst-case conditions. The weekday peak hour is 4:30-5:30 p.m. and the weekend peak hour is 2:00-3:00 on Sunday. The peak season is in August. When possible, counts were taken in August 1995; when this was not possible, counts were factored to reflect August conditions. The two construction years were 2000 and 2005 (tables 66 and 67). Counts were conducted at the following study intersections:

- Olympic Hot Springs Road/US 101
- US 101/Highway 112
- Highway 112/Power Plant Road
- Highway 112/Place Road
- Place Road/Ranger Road
- Highway 117/Marine Drive (in Port Angeles)
- US 101/Highway 117
- US 101/Laird Road
- US 101/Herrick Road
- Edgewood Drive/Lower Elwha Valley Road
- US 101/Old Olympic Highway
- Old Olympic Highway/Cays Road
- Old Olympic Highway/Sequim-Dungeness Way

Park visitor data also was used to estimate volumes on Olympic Hot Springs Road and to help determine seasonal traffic variations in the park area.

Intersection Operations. The intersection and operating conditions are indicated by a level of service (LOS) letter designation. Level of service provides a measure of delay ranging from A (free-flowing, minimal delay) to F (extreme congestion, long delays). For intersections with signals ("signalized"), average time stopped at the signal is estimated. For unsignalized intersections, total delay is estimated. When volumes exceed capacity, LOS * (star) appears. Although this also may indicate that the intersection operates at F, this is not always true.

Level of service is a qualitative assessment of intersection operations based on the average delay (in seconds) by vehicles. Delay is a measure of driver frustration, fuel consumption, and lost travel time. For intersections without signals, the total delay is calculated. Total delay is the difference between vehicles' actual travel times through the intersection and the travel time if the vehicles had not been stopped or slowed. For signalized intersections, stopped delay is estimated. Stopped delay is the time period when vehicles are in a fully-stopped position, and does not include deceleration/acceleration time or queue move-up time.

Level of service A represents minimal delays and is associated with free flowing traffic, while F is associated with long delays and poor traffic flow. The range of delay for each letter for unsignalized and signalized intersections is:

LOS	**Intersections without Signals** (total delay in seconds)	**Intersections with Signals** (stopped delay in seconds)
A	+5	+5
B	>5 and +10	>5 and +15
C	>10 and +20	>15 and +25
D	>20 and +30	>25 and +40
E	>30 and +45	>40 and +60
F	>45	>60

Source: 1994 Highway Capacity Manual Update

Level of service F is not necessarily indicative of intersection failure. Rather, F may indicate that drivers would experience long delays due to the timing of the traffic signal or other operational problems. High volumes of traffic may still flow through an intersection at F.

Delay is derived from analyzing the ratio of critical volumes to capacity. The software module cannot calculate level of service or delay when volumes exceed capacity by a certain amount. In that case, * (star) may appear in the

Highway 101 near the Elwha River. (Curtis Miller photo) calculation. Generally, * is shown when volume exceeds capacity. Although an intersection may operate at F when * appears, this is not always true. Level of service A through D are generally considered as acceptable operating conditions at intersections outside of urban areas.

Project impacts were determined for two future years, 2000 and 2005, and two time periods, weekday peak hour and weekend peak hour. Annual traffic growth rates were based on historical data gathered by the Washington Department of Transportation and Clallam County at area intersections from 1990-1993. The growth rate was determined to be 3.28% per year. The existing traffic volumes were factored up to reflect this annual growth rate.

Methods to Analyze Action Alternatives

In addition to those relevant assumptions and methods described above, the following are applicable to the action alternatives.

Assumptions. Peak activities related to trip generation would be expected to include:

- Approximately three truckloads of debris would be produced per day at Glines Canyon damsite. One of these loads would be carted away during the peak hour studied. Elwha Dam would have much greater activity during the final seven months of demolition, with an estimated maximum of eight truckloads per hour.

- The park entrance on Olympic Hot Springs Road would be closed during the project years (visitors/campers/hikers would not be using this entrance), thereby reducing trips on that road. Traffic on surrounding roadways would continue to grow at the annual rates discussed.

- Employee trips would take place outside of the peak hours and are not included.

Trip Generation/Distribution. The Glines Canyon damsite is assumed to generate a maximum of two trips in the p.m. peak hour. This was distributed as one trip exiting and one trip entering Olympic Hot Springs road in the p.m. peak hour. The Elwha damsite is assumed to generate up to 16 trips in the peak hour. This maximum number of trips does not change in future years or vary from weekday to weekend. These trips were distributed as eight trips exiting and eight trips entering Power Plant Road. All trips were then distributed according to routes for the nine different dump site destinations. Since three of the possible dump sites are clustered or exist in the same general area, seven alternatives are discussed throughout this section.

Alternative A refers to the three dump sites located off Ranger Road and/or Place Road. In this alternative all site-generated trips were distributed to and from an unspecified point on Ranger Road, which is representative of any one of the three dump sites.

Alternative B refers to the dump site adjacent to the Port of Port Angeles.

Alternative C refers to the site off Herrick Road, west of Olympic Hot Springs Road.

Alternative D refers to a the site off Lower Elwha Valley Road, north of the intersection of Laird Road/US 101.

Alternative E refers to a site off US 101 between Port Angeles and Sequim.

Alternative F refers to a site off Cays Road north of Sequim.

Alternative G refers to a site off Sequim-Dungeness Road.

Impacts of No Action

According to staff at Clallam County and the Washington Department of Transportation, no roadway improvements are currently planned in the project area in the near future. No information was available on other planned projects in the study area. Any traffic associated with such projects probably would already be reflected in the assumed annual growth rate.

Year 2000 Peak Hour Level of Service

The year 2000 turning movements were analyzed for level of service at the study intersections. Table 64 shows weekday peak hour levels of service for existing and background conditions. Several intersections will be more congested without the addition of project traffic by year 2000. Operations at Marine Drive/Highway 117 decline from C to *. However, only the westbound left movement would operate poorly, and it may be possible to correct this with adjustments to signal timing. Level of service declines from A to C at US 101/Highway 112 in background year 2000. Southbound left-turning traffic experiences increased delay with future growth.

The intersection of US 101/Old Olympic Highway declines from A to B, with the north- and southbound left-turning movements increasing delay.

Operations at Marine Drive/Highway 117 for the weekend peak hour decline from B to C in background year 2000. All other intersection operations remain unchanged from existing conditions.

Year 2005 Peak Hour Level of Service

Since it is unknown what year project construction would begin, two future traffic years were analyzed. Traffic volumes during the weekday and weekend peak hours for both years are as presented in table 65. Operations at Marine Drive/Highway 117 decline from C to *, although it may be possible to improve operations with adjustments to signal timing.

US 101/Highway 112 declines from A to F in year 2005. Southbound left-turning traffic from Highway 112 to US 101 experiences increased delays due to the increased volumes. Other movements continue to operate well.

US 101/Old Olympic Highway and Old Olympic Highway/Sequim-Dungeness Way decline from A to B, although both are still operating well. Weekend peak hour traffic also worsens. The intersection of US 101/Highway 112 changes from A to B, as does the intersection of Old Olympic Highway/Sequim-Dungeness Road.

Marine Drive/Highway 117 declines from B to * on weekends. Again, adjustments to signal timing could improve future operations. US 101/Old Olympic Highway declines from A to D, with increased delay for the north- and southbound movements.

Conclusion

Traffic at several intersections becomes more congested by either year analyzed for construction start-up (2000 or 2005). Levels of service decline at the

Table 64. *Peak Hour Traffic for the Year 2000 Compared to Existing Conditions (1995) for Both Weekday and Weekend Traffic*

INTERSECTION	WEEKDAY LOS (1995)	WEEKDAY LOS (2000)	WEEKEND LOS (1995)	WEEKEND LOS (2000)
Marine Drive/117	C	*	B	C
Highway 117/US 101	A	A	A	A
US 101/Highway 112	A	C	A	A
US 101/Olympic Hot Springs Road	A	A	A	A
Place Road/Highway 112	A	A	A	A
Ranger Road/Place Road	A	A	A	A
Power Plant Road/Highway 112	A	A	A	A
US 101/Herrick Road	A	A	A	A
US 101/Laird Road	A	A	A	A
Lower Elwha Valley Road/ Edgewood Drive	A	A	A	A
US 101/Old Olympic Highway	A	A	A	A
Old Olympic Highway/Cays Road	A	A	A	A
Old Olympic Highway/ Sequim-Dungeness	A	B	A	A

intersection of US 101/Olympic Highway of Marine Drive/Highway 117 during peak weekday traffic in the year 2000. This is true of the year 2005 as well, but levels of service at two additional intersections (Old Olympic Highway/Sequim Dungeness Rd. and US 101/Highway 112) have deteriorated as well. All four of these intersections also experience declines in LOS ratings during 2005 peak weekend traffic. Only the intersection of Marine Drive/Highway 117 falls one step in LOS during peak weekend traffic in the year 2000.

Impacts of the Proposed Action – River Erosion Alternative

The project impacts to traffic conditions in the area would be minor in most cases. At two intersections, Maine Drive/Highway 117, and US 101/Highway 112, background growth (i.e. projected traffic levels without project trucks added) would cause delays. The introduction of project traffic would contribute to poor operations at these intersections, and would cause the level of service (see methodologies above) to drop from B to C during peak weekend traffic in the year 2005 as a result. Otherwise, the LOS at all 13 intersections studied would remain the same with or without project traffic.

Table 65. *Peak Hour Traffic for the Year 2005 Compared to Existing Conditions (1995) for Both Weekday and Weekend Traffic*

INTERSECTION	WEEKDAY LOS (1995)	WEEKDAY LOS (2000)	WEEKEND LOS (1995)	WEEKEND LOS (2000)
Marine Drive/Highway 117	C	*	B	C
Highway 117/US 101	A	A	A	A
US 101/Highway 112	A	F	A	B
US 101/Olympic Hot Springs Road	A	A	A	A
Place Road/Highway 112	A	A	A	A
Ranger Road/Place Road	A	A	A	A
Power Plant Road/Highway 112	A	A	A	A
US 101/Herrick Road	A	A	A	A
US 101/Laird Road	A	A	A	A
Lower Elwha Valley Road/ Edgewood Drive	A	A	A	A
US 101/Old Olympic Highway	A	B	A	D
Old Olympic Highway/Cays Road	A	A	A	A
Old Olympic Highway/ Sequim-Dungeness	A	B	A	B

Alternative A

Trucks would move through five intersections to reach the three potential dump sites near Ranger Road. Adding truck traffic from the damsites to conditions expected in either year 2000 or 2005 would not change levels of service at any intersection. In addition to US 101/Olympic Hot Springs Road and US 101/Highway 112, traffic would move through Place Road/Highway 112, Ranger Road/Place Road, and Power Plant Road/Highway 112. All three remain level of service A with project traffic added (see tables 65 and 66).

Alternative B

All trips generated by the project were sent to the Port of Port Angeles under this alternative. In addition to US 101/Olympic Hot Springs Road, US 101/Highway 112, and Power Plant Road/Highway 112, traffic would move through Marine Drive/Highway 117 and Highway 117/US 101. No changes in levels of service would occur during weekday or weekend peak hours at

Table 66. *Year 2000 Peak Weekday/Weekend LOS Levels with Project Traffic Added*

INTERSECTION	WITH NO PROJECT TRAFFIC	ALTERNATIVE DISPOSAL LOCATION						
		A	B	C	D	E	F	G
Marine Drive/Highway 117	*/C		*/C			*/C	*/C	*/C
Highway 117/US 101	A		A			A	A	A
US 101/Highway 112	C/A	C/A	C/A	C/A	C/A	C/A	C/A	C/A
US 101/Olympic Hot Springs Road	A	A	A	A	A	A	A	A
Place Road/Highway 112	A	A						
Ranger Road/Place Road	A	A						
Power Plant Road/Highway 112	A	A	A	A	A	A	A	A
US 101/Herrick Road	A			A				
US 101/Laird Road	A				A	A	A	A
Lower ElwhaValley Road/ Edgewood Drive	A				A			
US 101/Old Olympic Highway	A					A	A	A
Old Olympic Highway/Cays Road	A						A	A
Old Olympic Highway/ Sequim-Dungeness	B/A							B

Note: If baseline conditions or project LOS changes from weekday to weekend peak hours, this is noted as a slash, i.e. A/B indicates weekday conditions are A, weekend B. Otherwise, all intersections remain the same LOS weekday or weekend.

any of these intersections for a start date of 2000 as a result of project-related traffic. This is also true for year 2005 weekday peak hour traffic. However, year 2005 weekend peak traffic at US 101/Highway 112 would decline from B to C with the addition of project trips.

Alternative C

In this alternative, waste disposal is assumed at a site on Herrick Road west of Olympic Hot Springs Road. Truck traffic from the Elwha damsite would travel through the intersection of Power Plant Road/Highway 112 to US 101/Highway 112 and south on US 101 to the intersection of US 101 and Olympic Hot Springs Road, turning west on US 101 to Herrick Road. No changes in levels of service at any of these intersections during peak weekday or weekend traffic would result from project traffic during the year 2000. This is true for peak weekday traffic for the year 2005 as well, but as described above for alternative B, project traffic would cause level of service at the intersection of US 101 and Highway 112 to decline from B to C.

Table 67. *Year 2005 Peak Weekday/Weekend LOS Levels with Project Traffic Added*

INTERSECTION	WITH NO PROJECT TRAFFIC	ALTERNATIVE DISPOSAL LOCATION						
		A	B	C	D	E	F	G
Marine Drive/Highway 117	*		*			*	*	*
Highway 117/US 101	A		A			A	A	A
US 101/Highway 112	F/B	F/B	F/C	F/C	F/C	F/C	F/C	F/C
US 101/Olympic Hot Springs Road	A	A	A	A	A	A	A	A
Place Rd/Highway 112	A	A						
Ranger Road/Place Road	A	A						
Power Plant Road/Highway 112	A	A	A	A	A	A	A	A
US 101/Herrick Road	A			A				
US 101/Laird Road	A				A	A	A	A
Lower Elwha Valley Road/ Edgewood Drive	A				A			
US 101/Old Olympic Highway	B/D					B/D	B/D	B/D
Old Olympic Highway/Cays Road	A						A	A
Old Olympic Highway/ Sequim-Dungeness	B							B

Note: If baseline conditions or project LOS changes from weekday to weekend peak hours, this is noted as a slash, i.e. A/B indicates weekday conditions are A, weekend B. Otherwise, all intersections remain the sam LOS weekday or weekend.

Alternative D

Waste from dam removal would be sent to a site on Lower Elwha Valley Road under this alternative. Trucks from Glines Canyon Dam would proceed north on Olympic Hot Springs Road to US 101 to Highway 112, where they would join truck traffic coming from the Elwha site. In addition to these intersections, traffic would pass through Highway 112/Power Plant Road, US 101/Laird Road, and Lower Elwha Valley Road/Edgewood Drive. Except for the intersection of US 101/Highway 112, which falls from B to C during the year 2005 peak weekend hour with the addition of project traffic, the level of service for all intersections remains unchanged from project traffic volumes.

The project impacts to traffic conditions in the area are generally minor and temporary.

Alternative E

In this alternative, all site-generated trips would be sent to a disposal location off US 101 between Port Angeles and Sequim. In addition to the intersections of US 101/Highway 112, US 101/Olympic Hot Springs Road, Highway 112/Power Plant Road, US 101/Laird Road, and US 101/Highway 117 discussed in other alternatives, traffic would pass through Marine Drive/Highway 117, Highway 117/US 101, and US 101/Old Olympic Highway.

Except for those described for other alternatives, no additional changes would occur for levels of service for any of these intersections in either year 2000 or 2005 as a result of project-generated traffic.

Alternative F

Alternative F, like alternative E, assumes waste would be disposed of at a site between Port Angeles and Sequim, located off Cays Road. In addition to the intersections described for alternative E, alternative F includes analysis of Old Olympic Highway and Cays Road. No changes in levels of service for either year 2000 or 2005 for peak weekend or weekday traffic are predicted as a result of project traffic for this intersection.

Alternative G

Alternative G assumes disposal of waste material at a site north of Sequim. Trucks would follow the same route as alternatives E and F, but would proceed east on Old Olympic Highway past Cays Road to the intersection of Sequim-Dungeness Way. This is the only new intersection. No change in level of service would be expected at this intersection as a result of project traffic for either year.

Cumulative Impacts

Cumulative impacts are the impacts of existing traffic and project impacts. The analysis of the traffic impacts of the proposed action are presented so that the cumulative totals are apparent.

Conclusion

The project impacts to traffic conditions in the area are generally minor and temporary. The project is expected to be completed within two years, after which time project traffic would cease and normal travel patterns for recreation trips resume in the Olympic Hot Springs area.

A maximum of 18 trips would be generated by the two sites in the weekday and weekend peak hours. With expected future growth rates, some intersections would operate poorly in 2000 and 2005 before project traffic was introduced. The introduction of project trips would contribute to the poor operations at these intersections.

Project trips would cause level of service to decline only at the intersection of US 101/Highway 112. In the year 2005 on the weekend, the addition of project trips would cause this intersection to drop from B to C, still within acceptable levels.

There may be concerns about truck traffic entering the highways from the site access points at Power Plant Road and Olympic Hot Springs Road. As a safety measure, flaggers may be used at these intersections to facilitate the introduction of trucks to the busy arterial roadways.

Impacts of the Dredge and Slurry Alternative

The slurry pipeline alignment for the road option falls almost entirely within the limits of the county right-of-way, except from Elwha Dam to the Strait of Juan de Fuca where the line passes under Highway 112, which is Washington State right-of-way. As long as installation followed standard practices for this type of work and met design and construction requirements, county and state officials contacted were receptive to the proposed alignment.

The slurry pipeline road alignment would not delay traffic except during the construction needed to bury the pipeline in the road. The pipeline would be buried as the road surface of one lane of traffic is removed. After placing the pipe, the road surface would be immediately replaced.

The pipeline would be on the road surface from Glines Canyon Dam to the river for approximately nine months. Dredging time, and hence the time the pipeline would be required, would be controlled by the rate of notching. Some area around the ranger station would be two-way traffic because there would be enough room to place the pipeline along the side of the road. For about one-half the distance from McDonald gauge to Glines Canyon Dam, construction would block the road to one lane for 90 to 120 days during installation of the pipe. Traffic delays would be localized. The total road length which would receive pipeline is about six miles. Otherwise, project traffic impacts are identical to the River Erosion alternative.

Conclusion

The Dredge and Slurry alternative along the road route would cause moderate traffic delays for approximately 90–120 days during installation of the pipeline along the county roads and would require significant sections of the roads to be resurfaced following construction.

With the river pipeline route, only minor traffic conflicts would occur in addition to the minor impacts of dam removal construction traffic, which are the same as for the proposed action. Impacts of this alternative would be very similar to the River Erosion option. There would be some additional truck traffic along the pipeline route if the line were buried beneath roadways.

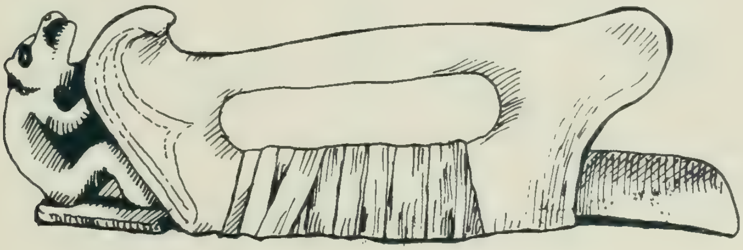
Indian Trust Resources

Summary of Regulations and Policies

The United States has legal obligations, described as "fiduciary" or "trust" duties, or "the federal trust responsibility" to protect the Indian trust resources described in Affected Environment.

President Clinton's April 29, 1994, *Memorandum for the Heads of Executive Departments and Agencies* directs that: "Each executive department and agency shall assess the impact of federal government plans, projects, programs, and activities on tribal trust resources and assure that tribal government rights and concerns are considered during the development of such plans, projects, programs, and activities."

Order No. 3175 (secretary of the interior, November 8, 1993) states: "The heads of bureaus and offices are responsible for being aware of the impact of their plans, projects, programs or activities on Indian trust resources. Bureaus and offices when engaged in the planning of any proposed project or action will ensure that any anticipated effects on Indian trust resources are explicitly addressed in the planning, decision and operational documents. These documents should clearly state the rationale for the recommended decision and explain how the decision will be consistent with the Department's trust responsibilities."



The assistant secretary for Indian affairs has elaborated on this policy, and says "Primary responsibility for carrying out federal trust obligations on tribal lands and in areas ceded by treaties rests with the Bureau of Indian Affairs, but all Federal agencies share responsibility when implementing laws that may affect Indian resources. Trust responsibility fulfillment includes protecting...treaty-ceded and usual and accustomed areas...and administering Federal projects in a manner which prevents the diminishment of associated fish and wildlife resources, and the tribal share in them. (Interior) bureaus and offices shall, to the maximum extent provided by law, decline to take or approve any action that could adversely affect the well-being of off-reservation trust resources or the meaningful exercise of associated off-reservation hunting, fishing, and gathering rights unless all adverse consequences are fully mitigated."

Methodologies for Analyzing Impacts

Each alternative was evaluated and compared to the others considering a number of factors, including:

(1) The impact on treaty rights to harvest Elwha River stocks, including the abundance of surplus fish available for harvest and the long-term productivity of each stock.

(2) Impacts on in-river and marine treaty-reserved usual and accustomed fishing places.

(3) Impacts on the shellfish fisheries in the Elwha River estuary and nearshore area, including productivity.

(4) Impacts on wildlife herds and other populations available to the tribe exercising treaty hunting rights.

(5) Impacts on the Lower Elwha Klallam Reservation and other tribal lands in the Elwha River valley.

Impacts of No Action

The dams have reduced the number of harvestable finfish in the river to near zero (without hatcheries, all native anadromous runs would likely die off eventually) and have contributed to the decline of shellfish populations by the near elimination of sandy substrate and reduction of estuary size and complexity. Fish habitat (i.e., the river itself, as well as estuarine habitat) and access to it has been severely reduced by the presence of the dams and reservoirs. Wildlife habitat (the river, riparian areas, estuarine, and upland forest habitat) has been inundated, and wildlife adversely affected by the loss of salmon as prey and as a source of nutrients. These trust resources — fish and wildlife populations and their habitat — are described in this documents in Impacts to Fisheries, Wildlife and Living Marine Resources sections.

The elimination of natural sediment transport has eroded tribal beaches, and the Elwha Dam poses a substantial risk to reservation residents and property should either fail (see Impacts to Public Health and Safety). Beach erosion is discussed in Impacts to Fluvial Processes and Sediment Transport, and in Impacts to Living Marine Resources sections.

To the extent that these resources — fish and wildlife populations, their habitat and Indian lands — are affected by a proposed action, the United States' trust obligation is implicated.

Conclusion

Choice of the No Action alternative would not further the federal trust responsibility, as it would: degrade the river's naturally spawning fisheries, block access to usual and accustomed fishing places, degrade shellfish habitat in estuarine and adjacent nearshore areas, inundate wildlife habitat essential to the production of game, continue erosion of the beach on the Lower Elwha Klallam Reservation, and expose reservation residents to a risk of catastrophic dam failure. Impacts to fisheries and to wildlife habitat are considered major and adverse. Impacts to shellfish and reservation beach erosion are presumed major. The risk of dam failure is unknown, but considered unacceptable by reservation residents.

Impacts of the Proposed Action – River Erosion Alternative

The proposed action, with appropriate prevention or mitigation of short-term turbidity impacts on fisheries and long-term increases in flooding frequency, would affirmatively meet the United States' trust responsibility in the following ways:

(1) Removing both dams would permanently restore salmon and trout fisheries by restoring habitat and access to it for nine of ten anadromous runs. These fish would occupy the river throughout the year (See Impacts of Proposed Action, Fisheries section in this document and Impacts to River Ecology in the programmatic EIS).

(2) Removing the dams and reservoirs also would provide access to tribal usual and accustomed fishing places along the river.

(3) The Elwha River estuary would return to its much larger pre-dam size and provide additional natural habitat for shellfish to grow, and salmonid finfish to rear. (See Living Marine Resources, Wildlife and Fluvial Processes and Sediment Transport sections for more information).

(4)About 562 acres of the land now inundated by reservoirs would return to forested uplands and provide habitat for a variety of species native to the area. In addition, returning salmon and sea-going trout to the river would provide prey for wildlife and nutrients to the river. This, in turn, would increase overall biological productivity of the aquatic and terrestrial ecosystems (see Impacts to Vegetation and Wildlife).

(5) Restoring sediment transport would help reverse erosion of beaches, the nearshore environment and Ediz Hook (see Fluvial Processes and Sediment Transport section for more information). Removing the dams would eliminate any risk of their failure and associated catastrophic flooding.

Cumulative Impacts

Only No Action has adverse cumulative impacts — the continued degradation of the ecosystem and the disruption of and risk to life and property on the Lower Elwha Klallam Reservation.

Conclusion

The proposed action would affirmatively meet the federal trust responsibility by restoring fisheries, and by restoring shellfish habitat, wildlife habitat and access to tribal fishing places. It would also help to reverse reservation beach erosion and would eliminate any safety risk the dams pose to downstream residents. These are major beneficial impacts to resources subject to the federal trust responsibility.

Impacts of the Dredge and Slurry Alternative

This alternative has the same impacts as the proposed action except that the federal trust obligation to provide harvestable fish and access to usual and accustomed fishing places may be met sooner than with the proposed action.

Boat launch at Lake Aldwell. (Maggi Johnson photo)

Conclusion

The Dredge and Slurry alternative would affirmatively meet the federal trust obligations by restoring fisheries, shellfish habitat, wildlife habitat and by restoring access to tribal fishing. It would also help to reverse reservation beach erosion and would eliminate any safety risk the dams pose to downstream residents. Fish restoration, and therefore obligation to provide harvestable fish and access to usual and accustomed fishing places, may be met sooner than with the proposed action. These are major beneficial impacts to resources subject to the federal trust responsibility.

Recreation

Summary of Regulations and Policies

The *Olympic National Park Master Plan* (NPS 1976) calls for managing backcountry areas as wilderness. The park's draft *Wilderness Management Plan* (NPS 1995a) establishes objectives and procedures to preserve wilderness areas in their natural condition, providing opportunities for education and solitude while limiting permanent improvements and structures.

The *Statewide Comprehensive Outdoor Recreation Plan* (1990) addresses several issues relevant to the Elwha restoration including the statewide priority for new trails and the disappearing free-flowing river opportunities in Washington State.

Methodologies for Analyzing Impacts

Methodologies to assess impacts on recreational users and facilities were based on reviewing Olympic National Park and state plans. Using existing condition information, impacts to recreation resources have been determined by (1) loss or displacement of recreational opportunities and facilities; (2) the number and type of activities that would be lost and recreation users displaced; and (3) the length of time activities would be disrupted due to the implementation of the dam removal plan.

A major impact to recreation resources implies the long-term loss or displacement of a popular activity or well-used facility without the opportunity for replacement in the region. A minor impact to recreation resources is indicated by little change to activities or short-term disruption to accessing facilities.

Altaire Campground on the Elwha River. (Curtis Miller photo)

Impacts of No Action

Recreational Facilities

At the time the dams were built, Olympic National Park had not been created and recreation was not an issue. However, the presence of Glines Canyon Dam inside park boundaries now is at odds with the wilderness recreation policy and purpose of the park. Those expecting to have a natural experience in a primitive environment would find the dam disruptive.

Visitation numbers indicate that the demand for recreational activities is on the rise both in Olympic National Park and the Elwha subdistrict of the park. There will be pressure to provide for future demands for recreational activities.

The dams created reservoirs, which are used by boaters and anglers. The reservoirs also resulted in increases in resident trout populations through the virtual elimination of competition from anadromous salmon and trout (see Fisheries Impacts of No Action for more information).

Recreational Fishing

The decline of Elwha salmon and steelhead as a result of dams (and other factors) are part of a trend as freshwater habitat in the Pacific Northwest is developed and degraded. The closure of the entire salmon sport fishing season along the coasts of Washington, Oregon, and part of California attest to the severity of the decline. This has had an impact on the Clallam County economy as well, as it has begun to change from a resource-based to a tourist-based structure (see Impacts to Socioeconomics) dependent on recreation activities for tourists. The Lower Elwha Klallam Tribal Fish Hatchery and Washington Department of Fish and Wildlife chinook rearing channel on the Elwha River have played a major role in keeping valuable sport species from disappearing altogether; wild runs are nearing extinction for all Elwha salmon (WDFW and Western Washington Treaty Indian Tribes 1994).

Resident trout have flourished without competition from anadromous salmon and steelhead. The Elwha River supported approximately 22,000 hours per year (in 1981 and 1982) of summer trout fishing in the reservoirs and below the dams, 8,500-9,500 of which were in the reservoirs (FERC 1993, pp. 3-44 and 3-83).

Conclusion

The dams continue to adversely affect the Elwha River anadromous fisheries and associated recreation. Without hatchery supplements, natural salmon and steelhead production on the river would continue at very low levels or die out. The Glines Canyon project also is incongruous with the pristine nature of most of the Elwha subdistrict of Olympic National Park and adversely affects those recreationists seeking a natural experience. The reservoirs created by the dams are used for flatwater fishing of trout, and resident trout populations are larger than under pre-dam conditions. Future demand for recreational activities would place additional pressure on the Elwha watershed.

Impacts of the Proposed Action – River Erosion Alternative

Recreational Facilities

The reservoirs and associated recreation would be eliminated if the dams were removed. River access points in the same general locations would be preserved, however. Lake Crescent and Lake Sutherland, eight to ten miles west of Lake Aldwell on Highway 112 offer alternative facilities for flatwater activities lost at Lake Mills and Lake Aldwell. The loss of reservoir recreation would be a major impact to local anglers and boaters. However, with close options for flatwater recreation, out-of-town visitors would experience only minor impacts from the loss of the reservoirs.

There would be a significant, permanent increase in both sport and marine fishing for salmon and anadromous trout.

Recreational Fishing

The removal of both dams would result in a major permanent benefit to the quantity and quality of recreational fishing, both marine and river, for anadromous species (see Impacts chapter, Fisheries section). Dam removal would add 5.3 miles of free-flowing river for fishing. The economic impact of expected increases in recreation-based tourism to Clallam County is analyzed in the Impacts chapter, Socioeconomics section of this document.

Sport fishing in the river would be adversely affected in the short term by sediment in the water, restricted access because of construction activities (two years), and the need to restrict fishing until native populations of anadromous salmon and trout are restored to the system (a decade or more for some species). There would be a permanent reduction in the resident trout fishery due to competition from anadromous fish. Approximately 2,300 steelhead anglers and 22,000 hours of summer trout fishing would be displaced for a short time during construction. Out of this total, the 8,500–9,500 hours of summer trout fishing in the two reservoirs would be permanently displaced.

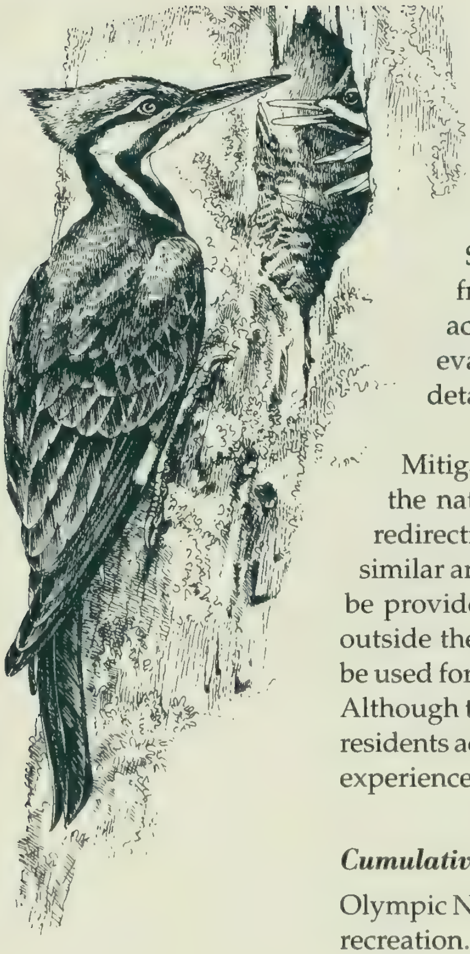
Other Recreational Activities

Camping, hiking, whitewater boating, sightseeing, picnicking, and wildlife observation opportunities would be moderately impacted by the short-term limitations on access to the Elwha watershed during construction. Dam removal activities would restrict access on Olympic National Park roads in the Elwha valley for as long as two years. These limitations would have a direct effect on the approximately 170,000 recreational users (see table 25) who would want to reach trailheads in the basin, gain access to the river for rafting or picnicking, travel the Elwha Valley Road (Olympic Hot Springs Road), and use area campgrounds.

Dam removal would add 5.3 more miles of free-flowing river. River features that would be created by dam removal are uncertain. Narrow steep reaches near the dams and more gentle reaches in the reservoirs might create new opportunities for whitewater users. The feasibility of using new reaches for rafting and kayaking, especially commercial operations, would depend upon the creation of boat launch areas and upon the safety of the new river features.

A trail between Cat Creek and Boulder Creek is proposed for the drained Lake Mills lake bed, and Olympic National Park would allow camping on the gravel bars in this section of river.

Noise and dust associated with dam removal activities are not expected to affect the recreation experience as the area would be closed to all visitors.



Mitigation

Mitigation options to reduce short-term impacts include implementation of an information program to direct flatwater users to other facilities and activity areas on the Olympic Peninsula. Several measures to more quickly restore fish and to protect them from the adverse impacts of sediment release are integral to both action alternatives and are outlined in the Alternatives chapter and evaluated in the Impacts to Fisheries chapter, as well as described in detail in appendix 2.

Mitigation options to reduce impacts of closing the Elwha subdistrict of the national park during dam removal include providing information, redirecting visitors to other areas of the park or peninsula that provide similar amenities, and interpreting the dam removal process. A shuttle could be provided to backcountry visitors to link trailheads with a parking area outside the construction zone. A shuttle or limited private access also could be used for commercial and whitewater users to reach the Altaire boat launch. Although this would reduce impacts on out-of-town visitors to the park, local residents accustomed to hiking or camping only in the Elwha subdistrict would experience a major impact during the two-year construction period.

Cumulative Impacts

Olympic National Park is presently managed for wilderness values, including recreation. Restoring the river's fisheries and ecosystem would add to the park's enhancement of hiking, river fishing, and other backcountry uses.

Clallam County is increasingly depending on recreation-based tourism as an economic base (see Impacts chapter, Socioeconomics section). The dam components left in place at Glines Canyon and possible interpretive programs explaining historic development in the Elwha watershed would draw additional park visitors.

In the long term, restoring the salmon fisheries and Elwha River ecosystem would probably become a tourist attraction in and of itself. Increased opportunities for sport and marine fishing, as well as the chance to experience the river in its natural and pristine form, are dependent upon restoration of fisheries resources and the health of the Elwha River ecosystem. Measures to manage sediment and maintain existing water quality, protect and enhance fish stocks, and revegetate reservoir bottoms would promote river-related recreation. Depending on the land management authority after dam removal, Elwha project lands would provide a range of recreational opportunities. Obtaining public access to the river and its resources is an important consideration and would be incorporated in a management plan for the area.

Conclusion

A permanent increase of 5.3 miles of free-flowing river and increases in river recreation-based tourism resulting from dam removal would be a long-term beneficial impact for visitors to the Olympic Peninsula. There would be a significant, permanent increase in both sport and marine fishing for salmon and anadromous trout. Lost flatwater boating and fishing opportunities on the reservoirs, and a reduced resident trout fishery would be a moderate adverse impact for primarily local users. But, other nearby lakes could provide alternate flatwater opportunities. Recreational pursuits in the Elwha watershed would be disrupted during dam removal activities and restoration activities due to closures of Elwha Valley Road (Olympic Hot Springs Road), trailheads, and campgrounds, and limitations on sport fishing in the river.

Impacts of the Dredge and Slurry Alternative

Effects of dam removal on recreation resources in the Elwha watershed would be the same as described in the proposed action. The only addition to the sediment management process in this alternative would be dredges working from barges on the reservoirs picking up sediments for transport to a slurry pipeline. Since the reservoir would be closed to recreational uses during this time, there would be no additional impacts on recreation.

The slurry pipeline would affect recreational resources differently depending on which of the routes would be used. The route from Lake Mills to Lake Aldwell is the same for all alternatives. The pipeline would parallel Elwha Valley Road (Olympic Hot Springs Road) for three miles in Olympic National Park — an unexpected addition to the park landscape (see figure 6 — Slurry pipeline map). For a short time, it would be visible to any visitors to the Elwha subdistrict.

From Elwha Dam to Freshwater Bay, the pipeline would be located in one of three alignments. The in-river alignment would be disruptive to river fishing and whitewater uses creating a short-term moderate impact. The on-dike alignment would be visible to some river recreationists but would not be directly disruptive to their activities. The third possible alignment would be burial along county roads and would not impact recreational resources.

Conclusion

A permanent increase of 5.3 miles of free-flowing river and increases in river recreation-based tourism resulting from dam removal would be a long-term beneficial impact for visitors to the Olympic Peninsula. There would be a significant, permanent increase in both sport and marine fishing for salmon and anadromous trout. Lost flatwater boating and fishing opportunities on the reservoirs, and a reduced resident trout fishery would be a moderate adverse impact for primarily local users. But, other nearby lakes could provide alternate flatwater opportunities. Recreational pursuits in the Elwha watershed would be disrupted during dam removal activities and restoration activities due to closures of Elwha Valley Road (Olympic Hot Springs Road), trailheads, and campgrounds, and limitations on sport fishing in the river.

The appearance of the slurry pipeline in Olympic National Park would produce a minor short-term adverse impact on recreationists seeking a wilderness experience. In addition, placing the pipeline in the river would disrupt river recreation activities.

Elwha Canyon, no date. (Clallam County Historical Society)

Land Use

Summary of Regulations and Policies

Please see the Land Use section in the Affected Environment chapter for a summary of the applicable regulations and policies. Due to the large number and complexity of plans and policies for the areas involved, these will not be repeated here.

Methodologies for Analyzing Impacts

Impacts of dam removal and associated actions on land use were examined by: the direct change (acreages) in land use and ownership, and the duration of these effects; conformance with current plans and policies; and indirect effects such as increased traffic, downstream flooding, and impacts on water users. The long-term removal or loss of a specific land use, non-conformance with current plans and policies, and the inability to mitigate effects constitute a major impact to land uses. A small change to current uses or a short-term disruption to current activities constitute a minor impact.

Impacts of No Action

Land Ownership and Land Use

Land ownerships and uses would not change from those described in the Affected Environment section on land use.

Consistency with Land Use Plans

Land uses at the project sites are in conflict with several of the plans and policies described in the Affected Environment section. Under the No Action alternative, National Park Service and Olympic National Park policies would not be met. National policy to restore "natural aquatic habitats and the natural abundance and distribution of native aquatic species, including fish, together with the associated terrestrial habitats and species" would not be met. Park policy to "conserve, maintain, and restore, where possible, the primary natural resources of the park and those ecological relationships and processes that would prevail if not for the advent of modern civilization" would also be in conflict with a decision to not remove the dams.

The National Marine Fisheries Service and the Pacific Fishery Management Council *Fishery Management Plan for Commercial and Recreational Salmon Fisheries Off the Coasts of Washington, Oregon, and California* states natural production of anadromous species should be restored to their optimum levels. Objectives state that whenever fish habitat or population losses occur as a result of development, the

Olympic National Park entrance on Olympic Hot Springs Road. (Curtis Miller photo) fishery agencies should actively seek full compensation, such as restoration of lost habitat or additional facilities, to increase fish production to previous levels. The presence of the dams, and blocked access and poor quality habitat which resulted, violates these objectives.

Clallam County's comprehensive plan states that it is critical that growth policies protect and enhance recreational resources, so that significant numbers of visitors, vitally important to Clallam County's economy, continue to visit the area. The dams have caused major adverse impacts to the Elwha River's ecosystem and native anadromous fisheries, reducing recreational opportunities, and so are at odds with this policy.

The goal of the county shoreline master plan is to preserve, to the fullest extent possible, the scenic, aesthetic, and ecological qualities of the saltwater and freshwater shorelines of Clallam County. The dams have significantly altered the river's ecology, and so are contrary to this goal.

Conclusion

Land use at the dam and reservoir facilities is inconsistent with policies of the National Park Service and Olympic National Park. The facilities are also inconsistent with the objectives of several local and regional planning documents.

Impacts of the Proposed Action – River Erosion Alternative

Land Ownership and Land Use

At Lake Mills, about 416 acres of lakebed would be exposed and converted to other national park use. The James River parcel (about 160 acres, roughly 30 of which are currently part of the reservoir) would convert to federal ownership and national park use. At Lake Aldwell, 268 acres of lakebed and 750 acres (1018 acres project lands minus 268) of additional lands would be converted to one of several different possible uses. These include national park lands, a national wildlife refuge, state management, or held in trust for tribal use (see discussion below). All potential land owners are either federal or state agencies. Two reservoir access sites and lake fishing on the two reservoirs would be permanently lost.

Within Olympic National Park, a large portion of this converted land would be managed for wilderness values. Several existing uses outside of the project lands would remain, such as campgrounds, Hot Springs Road and trailheads. Interpretive opportunities at the damsite would be developed to present the history of the projects, removal of the dams and recovery of the site.

Outside of the park, project lands include the Elwha Dam, Lake Aldwell and adjacent uplands. Once drained, the currently submerged lands will consist of the river, its adjacent floodplain, steep valley sides, and areas below the existing shore. Current upland areas are the existing forest lands, including steep banks and surrounding level bluffs, adjacent to the shore. The Elwha Restoration Act requires the secretary of the interior to consider "the suitability of such lands, or portions there of, for addition to the National Wildlife Refuge System; National Park System; transfer to the Lower Elwha Klallam Tribe in trust for tribal housing, cultural, or economic development purposes...and development and use by the State." This legislation also specifies that management of the project lands shall follow the policy of Public Law 90-542 (Wild and Scenic Rivers Act), with modifications necessary to restore fish resources and to protect the water supply.

To date, only the tribe has shown an interest in managing lands in trust, and has identified specific land uses and policies. The FWS has indicated that the parcel would be too small to manage effectively as a wildlife refuge, and has no interest in managing the lands. The lands qualify for designation as national park lands, but the Park Service is not pursuing their inclusion into the park.

The Washington State Department of Natural Resources coordinated a state response to DOI's earlier, programmatic EIS (DOI 1995, see comment letters, page 229) and indicated that it is not currently interested in managing the project lands. Impacts of state management would depend on how the project lands are used. The comment letter expresses the state's support of river restoration uses, Lower Elwha Klallam tribal interests, and public access uses.

The tribe has stated its intentions in the document, *Lower Elwha Klallam Tribe: Preliminary Land Use Plan for Elwha Project Lands*. The plan states that a primary objective is to restore the river's fishery and ecosystem and that any use of project lands must be compatible with this. The plan anticipates conservation, residential, economic development, and natural resource management districts. The plan identifies about 200 acres along the periphery of the Lake Aldwell project lands which would be suitable for residential and economic uses including tribal housing and businesses. Natural resource management activities may include riparian protection, viewshed protection, creation of primitive recreational opportunities, selective harvest of timber on long rotations, vegetative management for cultural resources, and wildlife habitat management. Conservation lands would be those that are unbuildable due to natural constraints or are vital to the success of restoration efforts. Allowed activities would include fishing, hiking, hunting, and gathering of traditional cultural resources, as well as vegetation management and other restoration efforts.

Impacts from designating Aldwell conservation areas would be minimal. Developing other land could have impacts on environmental resources depending on future anticipated uses. Development of land for residential, economic, recreation or resource management would involve removing vegetation, disturbing soils and resultant impacts on water quality, fish and wildlife. Grading roads, trails, staging areas or building pads would send particulates and other pollutants into the air and create noisy conditions which could disturb residents, recreationists or wildlife. It may also uncover or disturb important cultural resources. The development of the land may adversely affect scenic vistas now available of Lake Aldwell, and may also create additional traffic and congestion along access roads. Providing access to the river would have beneficial impacts on recreational river users, and development of the upland portion of the site could improve economic conditions for the tribe if it is the selected land manager. Use of the site may involve infrastructure such as water, sewer, electricity, etc., and the installation and use of these facilities may have additional indirect impacts on the resources described above.

Consistency with Land Use Plans

National Park Service policy (NPS 1988a) to restore "natural aquatic habitats and the natural abundance and distribution of native aquatic species, including fish, together with the associated terrestrial habitats and species" would be met by restoration of the river's ecosystem. One of Olympic National Park's management objectives, as stated in its Statement for Management (NPS 1989), is to "conserve, maintain, and restore, where possible, the primary natural resources of the park and those ecological relationships and processes that would prevail if not for the advent of modern civilization." This objective would also be accomplished.

Regional objectives of the Pacific Fishery Management Council to restore natural production of anadromous species to optimal levels would be met in the Elwha drainage under this alternative. Clallam County's objectives to protect and enhance recreational resources and to preserve, to the fullest extent possible, the scenic, aesthetic, and ecological qualities of saltwater and freshwater shorelines would be achieved on the Elwha River.

Solid Waste Disposal

Removal of both dams would generate a large volume of material which would require disposal. About 40,000 cubic yards of concrete, 45,000 cubic yards of rock fill, and 125,000 cubic yards of earth fill (sand, gravel and fine-grained materials) would be used in site reclamation of open pit mines or stockpiled for reuse. About 515,000 pounds of mechanical equipment, 950,000 pounds of electrical items (or about 730 tons), and 5000 cubic yards of additional waste (which includes fir mattresses, a timber access bridge, site buildings, window glass, chain link fencing, and cofferdam materials) would be disposed of in a sanitary landfill. Hazardous waste from the removal of contaminated soil and building materials would be trucked to a hazardous waste disposal site.

Nine sites have been identified in the Port Angeles/Sequim area that could accommodate concrete, rock fill and earth fill. The sites range from 3 miles to 32 miles of road distance from the dams; six of the prospective sites are within 16 miles of both dams. Several of the sites are capable of accommodating the full volume of concrete and common excavation materials. It is also possible that material would be distributed between disposal sites. The Traffic section of this EIS analyzes the impacts from transporting these materials to disposal locations.

There would be a permanent impact to land use associated with accepting waste and rubble from dam removal. Disposal of the majority of the material (concrete, rock and earth fill) would take place in either former surface mines or industrial sites, and the impact to land use would be minor.

Cumulative Impacts

Land use is a resource category which, in its broadest sense, overlaps with many other resource elements. Reference should be made to other sections of this document to gain a broad view of impacts on current as well as future land uses and possible mitigating measures. These environmental consequences include impacts on flooding (for effects of aggradation on downstream land uses), surface and groundwater (for effects of sediment release to water quality and quantity), traffic (for effects of construction traffic), recreation (for effects on recreational opportunities due to changes in the resource base), and socioeconomics (for socioeconomic effects of dam removal on current and future land use and development).

Conclusion

Land uses at the Glines Canyon Dam and Lake Mills would change, but would conform with National Park Service policies and would be a permanent beneficial impact. While lands associated with the Elwha Dam and Lake Aldwell would be managed for restoration of the Elwha River ecosystem, impacts on new upland uses would depend on the managing authority and its plans for the land. The long-term restoration of shoreline areas and anadromous fisheries would achieve objectives of several regional and local land use plans.

Impacts of the Dredge and Slurry Alternative

Land Ownership and Land Use

Expected land ownerships resulting from this alternative would be the same as those under the proposed action, while effects on land uses would be similar with the following exceptions. The slurry pipeline would affect land uses differently depending on which alignment is used. The route from Lake Mills to Lake Aldwell is the same for all alternatives. The pipeline would parallel the Elwha Valley Road (Olympic Hot Springs Road) for 3 miles within the park and be visible to any visitors to the area for the duration of its use.

From the Elwha Dam to saltwater, alignment A would follow the river. The pipeline would be placed in the riverbed or on the Lower Elwha Federal Flood Control Levee. If placed in the riverbed, river recreation users would be adversely affected during the 18 month to two-year dam removal period. Alignment B would follow county roads for its entire length and the pipeline would be buried. Construction under this alternative would affect access to local residences and businesses as well as impact adjacent land uses with dust and noise.

Consistency with Land Use Plans

This alternative would achieve the same land use objectives as discussed under the proposed action.

Solid Waste Disposal

Solid waste disposal would also be the same as under the proposed action.

Conclusion

Compared to the proposed action, impacts on existing land uses would be largely the same. There would be additional short-term effects associated with the construction and use of the slurry pipeline. These impacts would be localized and of short duration.

Elwha valley from trail above Elwha Campground. (Charles Scott photo)

Aesthetics

Summary of Regulations and Policies

The National Park Service has not developed a visual resource management system for public lands under its jurisdiction; however, the overriding management purpose in a park is preservation of all significant resources, including the scenery. The National Park Service organic act states that one of the fundamental purposes of a national park is ..."to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner and by such means as would leave them unimpaired for the enjoyment of future generations."

The Glines Canyon Project land and Lake Mills are within Olympic National Park. Most of the park lands in the Elwha watershed are designated as wilderness and managed to protect wilderness character and ecosystem values. Olympic National Park has established visual themes through architectural and siting guidelines for visitor and administrative facilities that emphasize natural characteristics such as colors and patterns that blend with the natural landscape (*Resource Management Plan* 1991; NPS 1976; NPS 1989). More information on park policies is available in the Aesthetics, Affected Environment section of this document.

The Elwha Project land and Lake Aldwell are surrounded by public and private land owners. The Clallam County comprehensive plan, which regulates uses of private lands, does not have policies or programs related specifically to scenic values within the Elwha River watershed. Olympic National Forest lands at the south end of Lake Aldwell are being managed according to the visual quality objective of "partial retention" (changes to the landscape remain visually subordinate to the characteristic features and patterns of that landscape). The Washington Department of Natural Resources (DNR) manages lands within the viewshed of the lake. Much of this land is scheduled to be logged within five years. The DNR does not manage public lands to protect aesthetic or scenic values.

Methodologies for Analyzing Impacts

Impacts on visual/aesthetic resources have both a physical component (change in the landscape character) and a viewer component (response to that change). Visual/aesthetic resource changes as a result of the dam removal were analyzed by comparing the existing visual character of the landscape and the degree to which the actions contrast or conform with that character. Viewer response was analyzed as (1) viewer exposure to visual resource change — whether the action would be visible and if so, from where, at what distance, for what duration and by how many viewers, and (2) perceived viewer sensitivity, which is a function of the extent to which viewer activity is dependent on visual quality.

Glines Canyon Dam. (Charles Scott photo)

Visual simulations showing before and after conditions were developed to help assess contrast and change following dewatering and dam removal. EIS team members reviewed key viewing areas to establish which views would be represented. All of the simulations shown here are based on photographs. The reservoir simulations combined photographs with three dimensional digital models based on existing topographic information and cross sections developed for this EIS.

Figures 23-26 show before and after conditions for the Elwha Dam and Lake Aldwell. Figures 27-30 show before and after conditions for Glines Canyon Dam and Lake Mills.

A major visual impact consists of a significant change that conflicts with the existing landscape character and is seen by viewer groups over a long time period. A minor visual impact consists of little change in existing landscape character and minor effects on viewer groups.

No Action Alternative

Lake Mills would continue to be a significant visual feature for visitors to the Elwha River valley. The reservoir would remain in strong contrast to views of the existing river valley. Glines Canyon is blocked by a dam that contrasts in form, color and texture with the intrinsic character of the steep, narrow, bedrock gorge. The level of Lake Mills fluctuates and exposes shoreline, as it is influenced by the management of water release rates. Project development around the dam, including the powerhouse, transmission lines and outbuildings, contrasts with management objectives for the wilderness area surrounding the project lands.

Lake Aldwell would continue to be a significant visual feature in intermittent views from Highway 101 and the Highway 101 bridge and in sustained views experienced by visitors to the lake. The Elwha Dam and associated structures and development contrast with the intrinsic landscape character of the steep bedrock walls of Elwha Canyon.

Any new programs designed to improve the dam's safety, power reliability and/or their fish passage capabilities would necessitate changes to the current structures as well as changes to the management of the projects. Physical changes could be expected to impact the existing character of the landscape.

Conclusion

Major impacts associated with the damming of a once free-flowing river in a naturally appearing landscape would remain.

Impacts of the Proposed Action – River Erosion Alternative

Long-term Restoration

Removal of the two dams would have an immediate, long-term impact on the visual resources of the Elwha River watershed. The most dramatic would be the disappearance of the reservoirs resulting in more spaciousness of the two newly drained valleys. The effects would cover the entire viewshed.

In both valleys exposed by draining the reservoirs, the river is expected to take a braided channel form similar to that of Krause Bottom, upstream from Rica Canyon. Natural and manipulated revegetation would result mostly in conifers in the valley side slopes and mixed conifers and deciduous trees on the terraced valley bottoms (see Impacts to Vegetation; and Appendix 3, Revegetation Plan). The Krause Bottom example shows a dense deciduous community of alders, cottonwoods, and willows crowding the valley bottom and river lands. Periodic channel movement and deposition would wipe out newly established vegetation, leaving exposed sandbars throughout the river's movement zone. (Also, see Impacts to Fluvial Processes and Sediment Transport in this document).

Site of present Elwha Dam prior to construction, circa 1895-1900. (Daishowa/James River Company photo)

Elwha Dam/ Lake Aldwell. Figures 23 and 24 show the Elwha Dam before and after removal. Figure 25 shows a scene of Lake Aldwell from the north end of the reservoir on the west side of the dam, looking down stream (to the south). The character of the forested foothills landscape area of the Elwha valley forms a backdrop for the flat-water form of the reservoir which dominates the scene. A strong edge is created where the naturally vegetated shoreline meets the water. Following dewatering, a major, short-term (up to three years) impact would be associated with the exposure of 270 acres of reservoir bottom to local residents and recreation users. Figure 26 simulates what the view of the river valley would be like approximately 20 years following dewatering and dam removal. The landscape is in the process of recovery. The river has reestablished a braided channel in more or less the same location as the historic channel 80 to 100 feet below the surface of the existing reservoir. Forms and features represented by floodplains, meanders, undercut slopes, and terraces are evident. Native vegetation has reclaimed the exposed reservoir slopes and bottom lands. Braided river movement would periodically expose islands and sandbars.

Glines Canyon Dam/ Lake Mills. Figures 27 and 28 show Glines Canyon Dam before and after removal. Figure 29 is a photograph of Lake Mills from a point at the north end and to the west of Glines Dam, looking south. The natural character of the mountainous landscape area of the valley serves as a backdrop for the flat form of the reservoir which dominates the foreground view. In the distance, mountains and forested hillsides characterize the scene. Following dewatering, 415 acres of reservoir bottom would be exposed to park visitors.

Two simulations were developed from this viewpoint, representing different time frames. One, figure 30, simulates the view 20 years after dam removal. The other (not in this DEIS but available from the National Park Service) shows the same area only three to five years after dewatering and dam removal. The river has taken on many of the characteristics of a free-flowing river, braiding through the floodplain between river terraces. Early successional vegetation has reintroduced itself to the exposed reservoir bottom. By 20 years (see figure 30), the river has re-established a meandering channel through the former reservoir bottom. Forms and features normally found in free-flowing rivers are present. These include recent meanders, gravel bars, young alder on newly exposed ground, fallen trees in the water and eroding terraces. Vegetation has matured and diversified, although it is still much smaller than the mature coniferous forest above the former reservoir level.

Short-term Impacts

Until vegetation begins to take hold in two to three years, the loss of large water bodies and the exposure of nearly 680 acres of reservoir bottom would have a major impact on the visual/aesthetic resources in the Elwha watershed. There is a great deal of contrast between the No Action and the River Erosion alternatives due to the change in landforms and water features. The removal of the water in the reservoirs, exposure of the bottom, and construction activities would be visible to local residents park visitors, and along Highway 101. During windy days, remaining fine sediment may become airborne and reduce visibility. Added turbidity to the Elwha River would moderately impact the river environment in the short-term. Mitigation to reduce the aesthetic impacts of reservoir loss and turbidity includes recontouring reservoir sediments and the implementation of a revegetation plan which emphasizes native materials and diversity (see appendix 3, Revegetation Plan). The new river shoreline, steep terrace walls and the old shoreline are spots where adding plant material would soften and feather the exposed edge.

Impacts of removing the dams and associated facilities from the canyon landscapes would be localized to the immediate area around each damsite. The removal of the Elwha Dam would have an immediate short-term major impact on aesthetics as heavy equipment and removal activities take place. Figures 23 and 24 illustrate the before and after view of the Elwha damsite (see the Alternatives chapter for description of dam removal methodology). Over the long-term, major beneficial impacts to aesthetics would occur as the damsite is returned to more natural conditions.

Figures 27 and 28 illustrate before and after views of the Glines Canyon Dam. Removal of the dam would have a major short-term impact on aesthetics as heavy equipment and removal activities take place. Several elements of Glines Canyon Dam that are of historic importance would be retained (see

Figure 23. *Elwha Dam Area — Current Conditions*

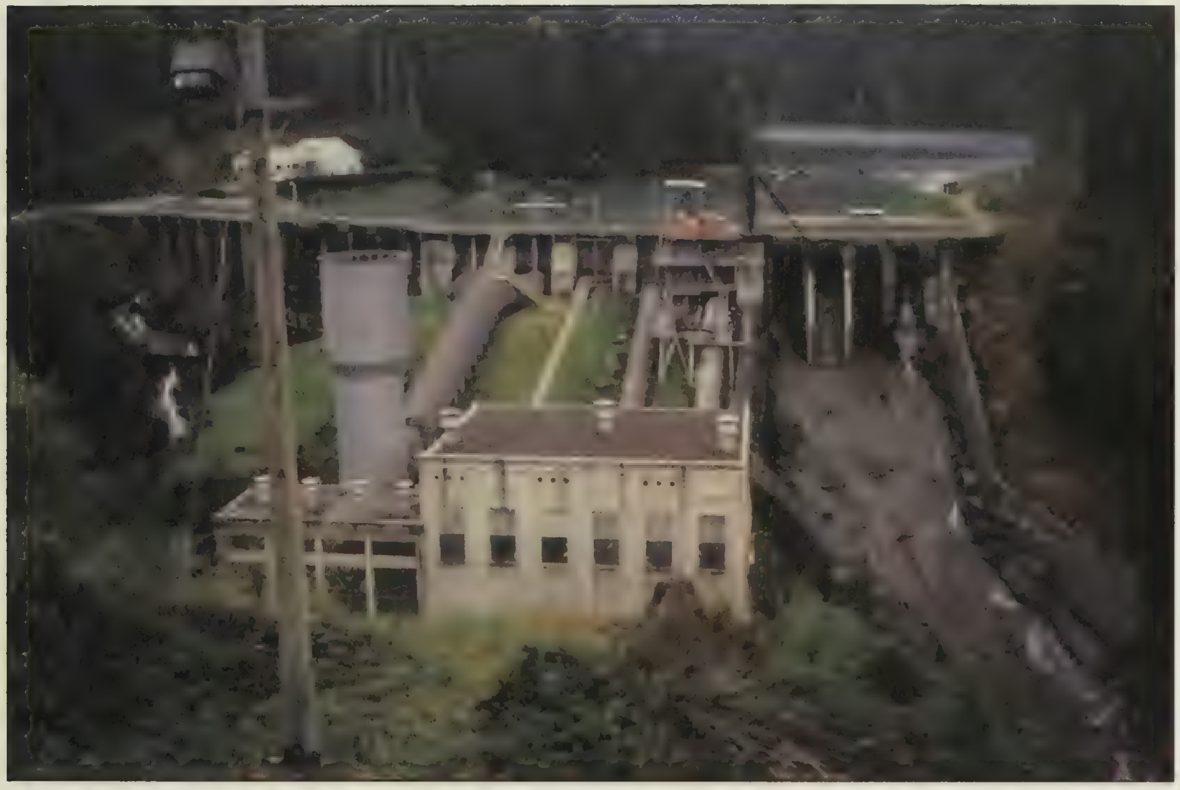


Figure 24. *Elwha Dam Area After Dam Removal*

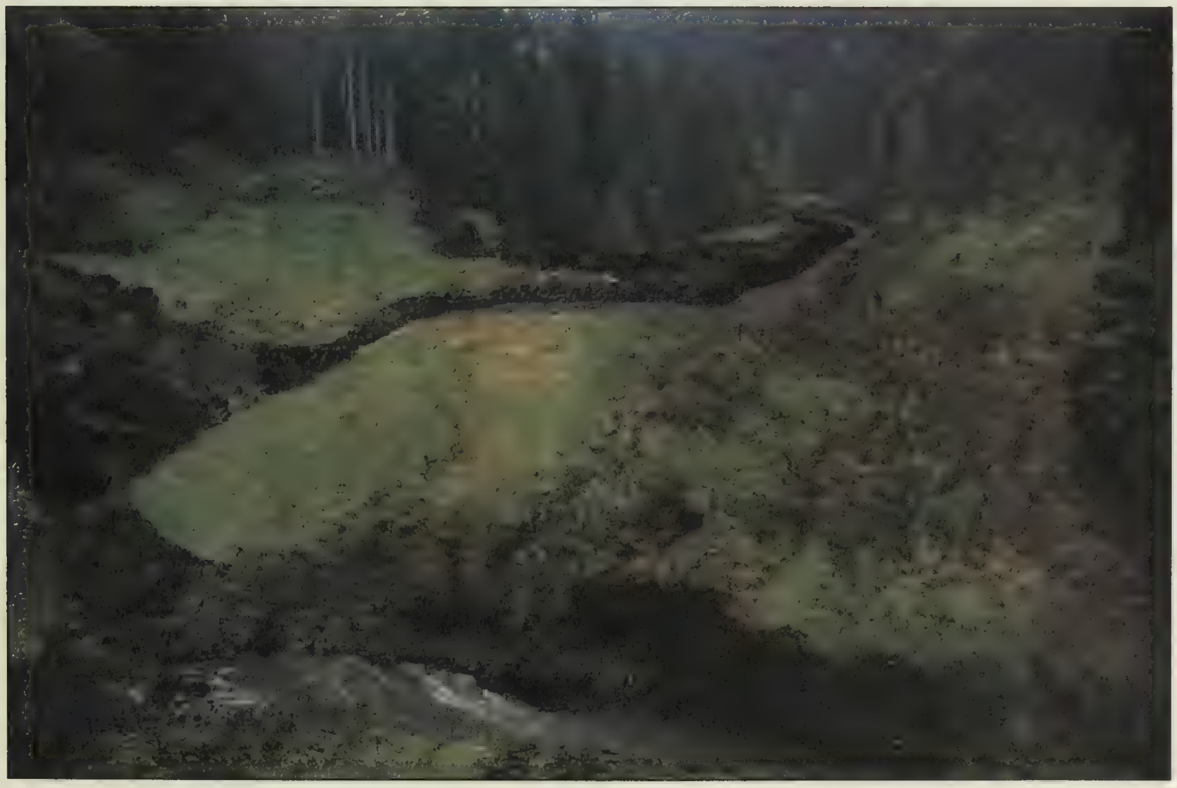


Figure 25. *Lake Aldwell — Current Conditions*

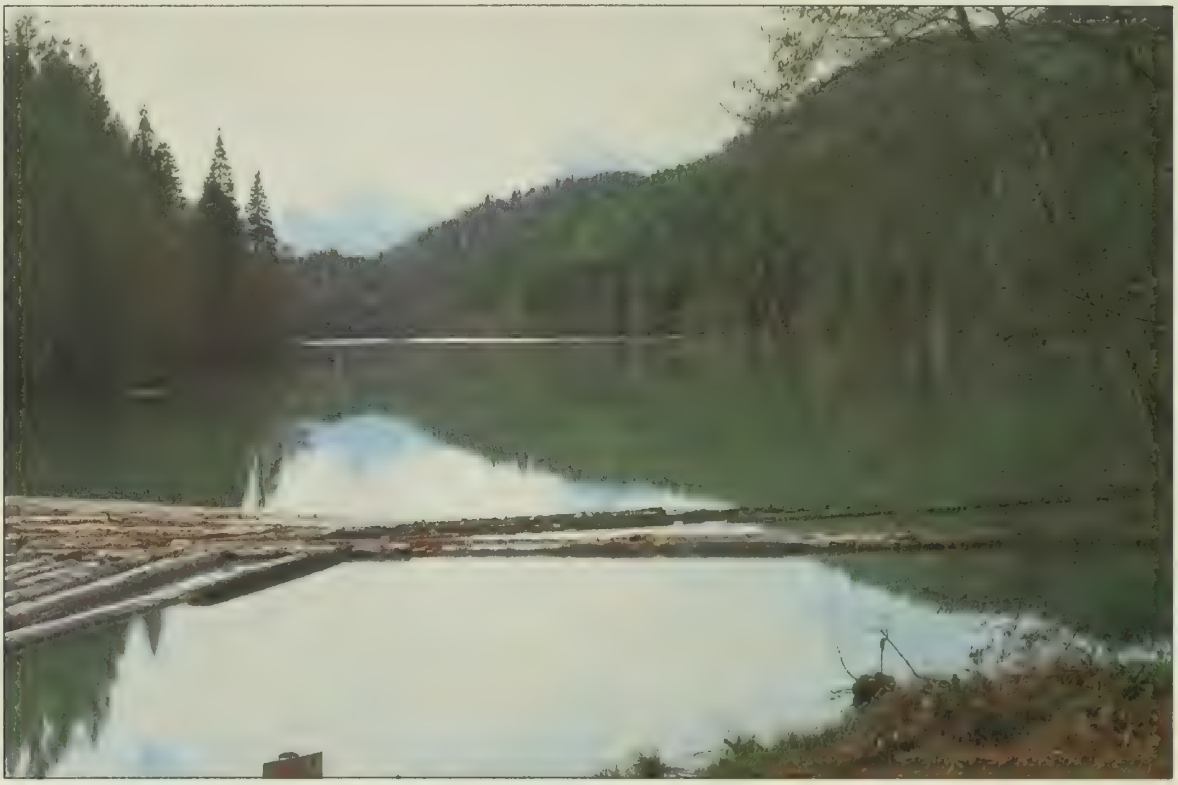


Figure 26. *Lake Aldwell — 20 Years After Dam Removal*

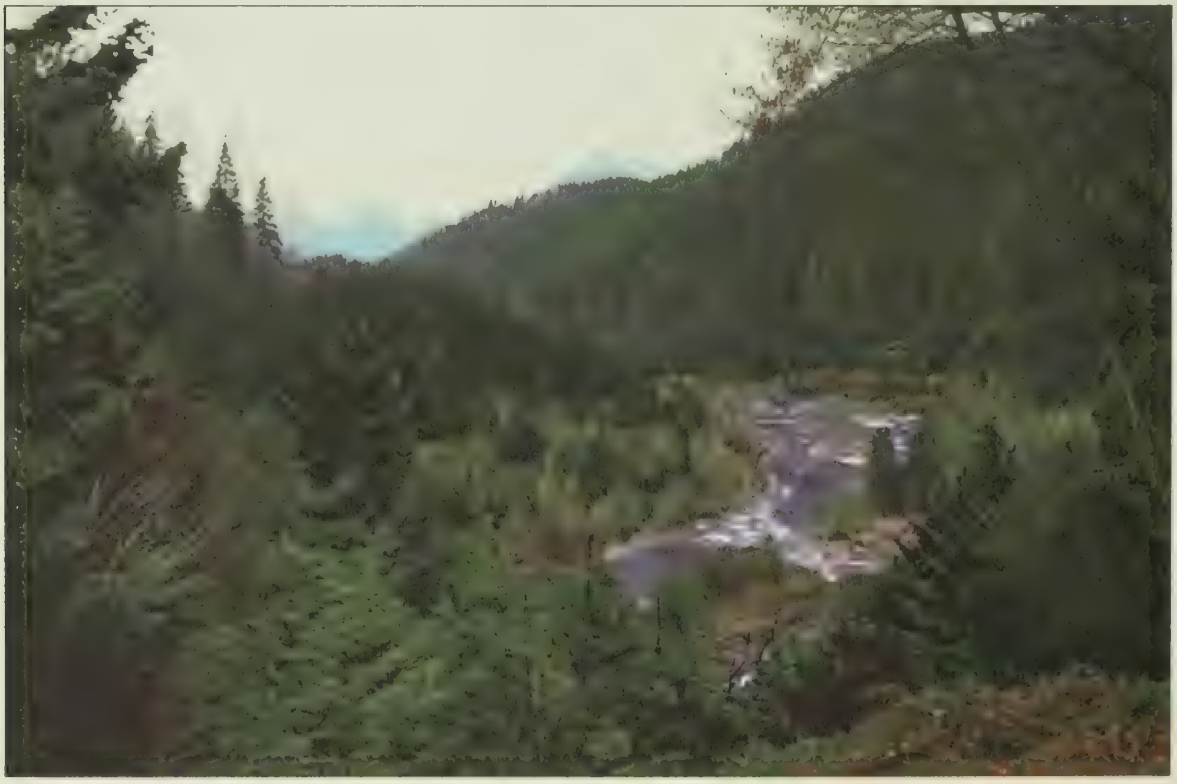


Figure 27. *Glines Canyon Dam — Current Conditions*

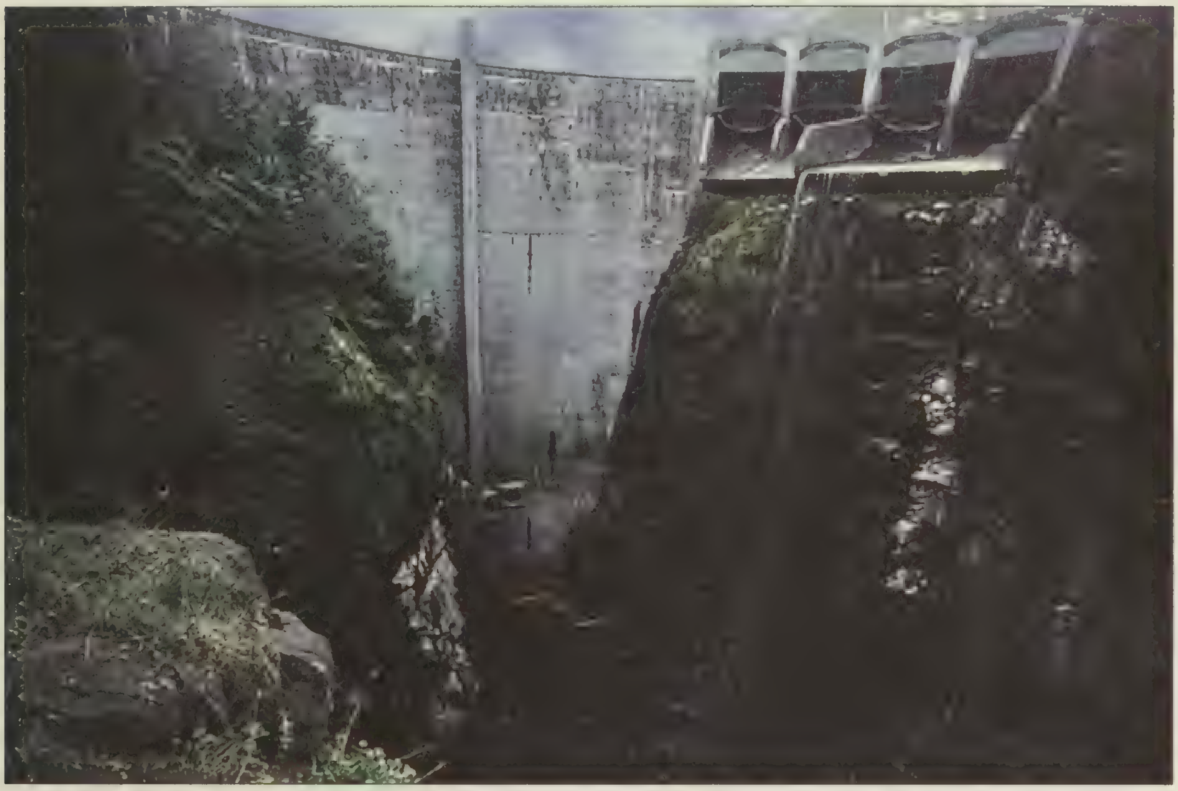


Figure 28. *Glines Canyon Dam Area After Dam Removal*

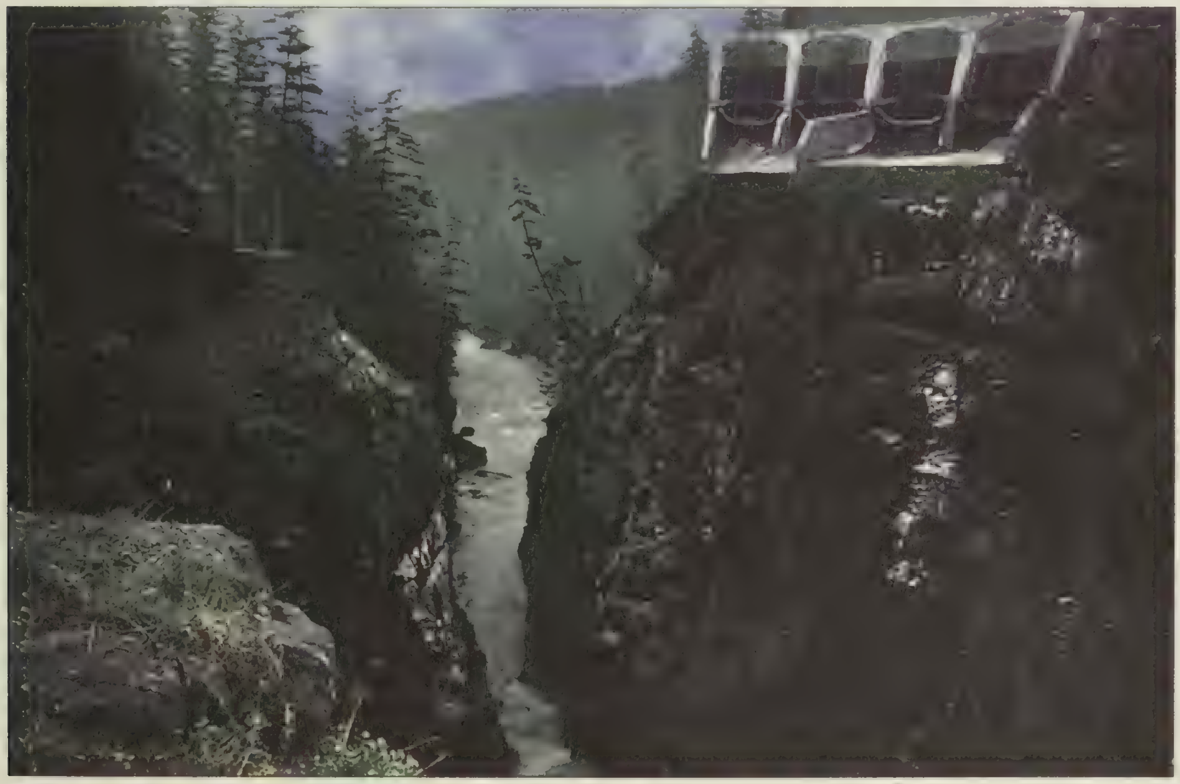


Figure 29. *Lake Mills Looking South — Current Conditions*

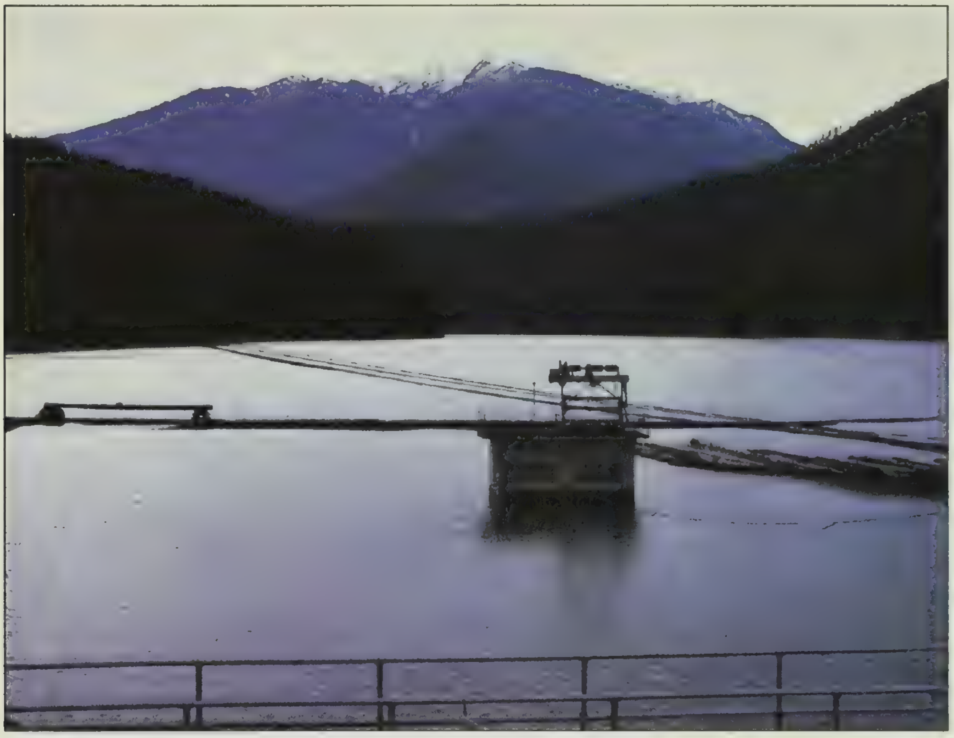
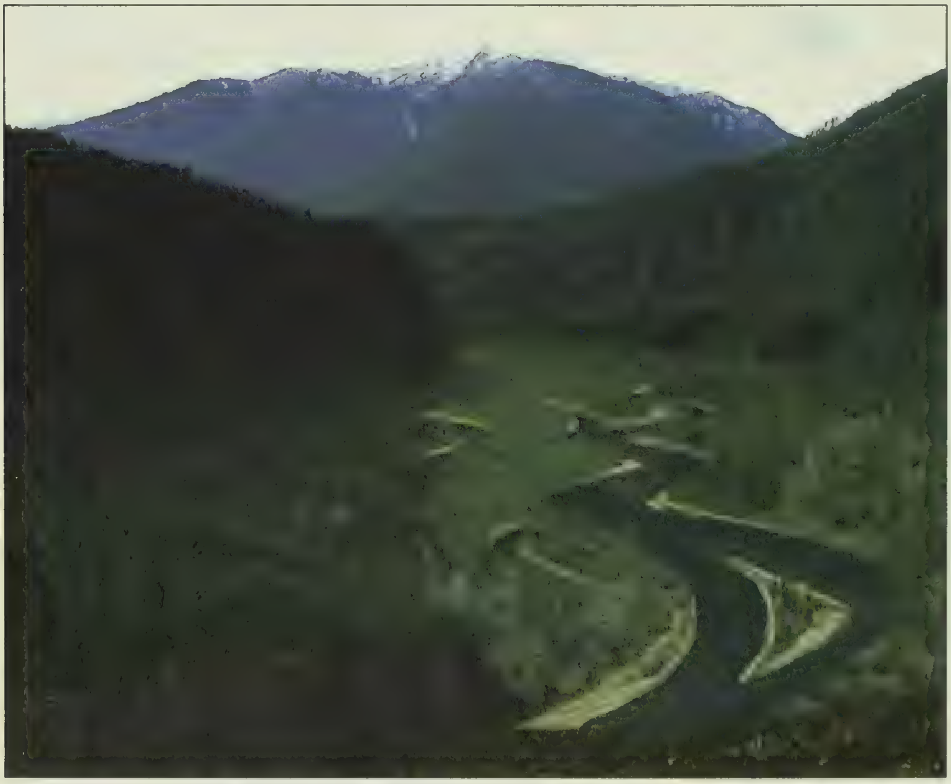


Figure 30. *Mills Valley Looking South — 20+ Years After Dam Removal*



Alternatives chapter). Over the long term, beneficial impacts would occur as the damsite is returned to more natural conditions, blending in with the backdrop of the restored river valley. The park service, as a long-term goal, would implement a public education and interpretive program focusing on themes related to the restoration of the Elwha ecosystem as well as site-specific historic locations.

Cumulative Impacts

Management of the restored landscape within Olympic National Park for wilderness values would maximize the long-term benefits to visual resources in the Elwha River valley. Outside of the park, management for ecosystem restoration would also result in long-term benefits to visual resources. Some project lands outside of the park may be managed by other entities for a variety of uses (See Land Use section.) Cumulative aesthetic resource impacts to these areas would depend upon the objectives, uses, access, and density of development pursued by the managing authority; however, given that the entire river corridor would return to more natural conditions, cumulative adverse impacts to aesthetic resources would be minor.

Conclusion

Removal of the two Elwha dams and reclamation of the reservoirs would affect the visual and aesthetic resources in the watershed in both adverse and beneficial ways. Short-term (up to three years), adverse impacts have to do with the change between the large, flat water bodies and the exposed reservoir bottoms following dewatering. Permanent major beneficial effects would occur as the Glines Project area "greens up" and reverts back to its natural character. In addition, the reversion to the natural character is consistent with the policies and plans of ONP in the watershed. Long-term effects within the viewshed of Lake Aldwell are more difficult to assess and depend on which government entity assumes jurisdiction of the Elwha Project lands. The reservoir bottom would most likely revert to a natural-appearing river/riparian condition while the upland portions could become resource lands or be converted to other uses.

Impacts of the Dredge and Slurry Alternative

Effects of dam removal on the visual/aesthetic resources of the Elwha watershed would be as described above for the proposed action. The only addition to the landscape would be dredges working from barges picking up lake sediments for transport into a slurry pipeline during the reservoir drawdown. This additional element is considered minor compared to the effects of the drawdown process itself. In addition, public access to the construction area would be controlled, limiting the number of people who would see the process.

The slurry pipeline would affect visual/aesthetic resources to different degrees depending on which alternative route is used. The route from Lake Mills to Lake Aldwell is the same for all alternatives (see figure 6). A short-term, moderate impact to the scenic landscape would be expected as the pipeline parallels Olympic Hot Springs Road (Elwha Valley Road) in ONP for 3 miles. Its form is incongruent to the existing character of the park landscape and it would be visible to any park visitors traveling along the road.

From Elwha Dam to the Strait of Juan de Fuca, the pipeline would follow either a gravity flow route (the river or along the Lower Elwha Federal Flood Control Levee), or be pumped in a pipeline buried along 6.5 miles of county roads. In either case, the visibility of the pipeline to river users and adjacent property owners and the contrast of the pipeline in the natural-appearing river environment would result in a moderate impact. The duration of the impact would correspond to the time required to dredge the reservoirs (approximately nine months).

Use of a slurry pipeline would substantially reduce the turbidity of the Elwha River during dam removal, and so would have less impact on the visual resource that clear running water represents to users and visitors than the proposed action.

Conclusion

In addition to the impacts described for the proposed action, there would be a net increase in short-term effects associated with the use of a dredge and slurry pipeline, although river turbidity would be less severe during dam removal. Impacts are associated with the introduction of a visually incongruent element, the pipeline, into the park and the river landscape.

Required Impact Sections

Impacts on Energy Consumption

The implementing regulations of the National Environmental Policy Act require that environmental impact statements discuss energy requirements and conservation potential of alternatives. Much of this information is embodied in the economic analysis of replacement power, located in the Impacts to Socioeconomics section of this document, the EIS to which it is procedurally connected (DOI 1995) as well as in the adopted and incorporated sections of the *Draft Staff Report* and *Elwha Report*.

In this section, the Department of the Interior details how much power the Daishowa Mill, would need to replace if both dams were removed. Daishowa uses 172 average annual gigawatt hours of power from the dams, and approximately 400 overall. If both dams were removed, no power would be produced from the plants. The mill would receive replacement power, which could be generated from a variety of existing or new sources from the

Bonneville Power Administration grid (FERC appendix A, Part 9). For purposes of costing only, interior presumed the hydropower supplied by the dams would be replaced by sources of energy available to the Bonneville grid — and at costs estimated for regional replacement of power by Bonneville. These costs are estimated to increase over the next 20 years at rates equivalent to increases in the real cost of natural gas.

Since Daishowa instituted conservation measures in 1989, accounting for an annual savings of 26.6 gigawatt hours, conservation potential at the mill is minimal. An energy audit conducted for the City of Port Angeles Light Department in 1991 identified potential additional savings of 9.6 gigawatt hours annually, approximately 5.5% of the current power production of the dams. These savings could be realized by installing adjustable speed drives and high efficiency motors. Other energy saving items were identified, but their cost-effectiveness was not determined in the audit.

Regionally, the Northwest Power Planning Council has estimated conservation potential of 1,500-4,000 megawatts (Elwha Report, p. 124; FERC 1993). Through efficiency improvements, another estimated 370 megawatts would be available. Cogeneration, or the use of one fuel source to generate power for use and also heat or steam for re-use, is available both regionally and at the mill. At the mill, wood waste could be burned in a boiler to produce approximately 15 megawatts (based on the size of the boiler and availability of wood waste). Regionally, up to 2,200 megawatts may be available (FERC 1993, Table 2-12).

Unavoidable Adverse Impacts

If either the River Erosion alternative or Dredge and Slurry alternative is implemented, there would be an unavoidable average annual loss of 172 gigawatt hours of hydropower. Both reservoirs and the recreation they support (flat-water fishing and boating) would be lost. The loss of the reservoirs would also displace wintering trumpeter swans and some other wildlife at Lake Aldwell.

The dams and associated buildings are considered historically important as examples of early hydropower production facilities. Although inventorying and recording features of both projects through the Historic American Engineering Record and other measures would provide mitigation, the structures would be lost.

The restoration of natural transport of sediment could also have impacts. A marine biotic community that has adapted to the lack of sediment in the nearshore area at the mouth of the Elwha River would be changed over time to one that prefers sandy substrate. The river elevation would rise in some places as bedload material was restored, resulting in a wider meander and more frequent localized flooding that could affect both private and cultural properties. Water downstream of the dams would have more organic material and nutrients than it does today. This would increase productivity of the aquatic and terrestrial ecosystem, and require mitigation to protect human users.

In the short term, construction would create traffic and noise that could affect wildlife, species of special concern, and recreationists. Roads within Olympic National Park would be periodically closed during dam removal and strengthened to withstand high loads.

Disposing material removed from the dams would require an estimated 255,000 cubic yards of space. A slurry pipeline to carry sediment from behind the dams would either be temporarily located on land or in the riverbed if this sediment management option were selected.

The release of sediment from behind the dams could severely affect aquatic life in the short term if unmitigated. Mitigation would reduce this impact to fish and would eliminate impacts to municipal and industrial water users.

The draining of the reservoirs would expose large, flat, incongruous surfaces to recreationists and motorists for two to three years following dam removal until vegetation takes hold.

Short-term Uses vs. Long-term Productivity

This section compares the short- and long-term environmental effects of decisions. Although projects traditionally result in short-term gains and long-term losses, the restoration of the Elwha River ecosystem and native anadromous fisheries would do the reverse.

Short-term impacts from construction and sediment release on fisheries, water quality, flooding, wildlife, living marine resources, recreation, land use, and aesthetic resources would last between six months and three years. Dam removal, and hence impacts from construction noise and traffic, would be completed in 18 months. Sediment loads of suspended solids would begin to return to normal the first year following dam removal. For example, Mount St. Helens eruption added 50 million cubic yards of debris to the South Fork Toutle River in 1980, and the river was nearly clear three years later. The first steelhead returned in three months and the river population exceeded agency goals within five years. Since silt and clay stored behind the two Elwha dams are only a small portion of that deposited in the South Fork of the Toutle, fish are expected to recover well within these time frames. Revegetation of the reservoir shoreline would start immediately, and be clearly visible within three years.

In the long term, the Elwha River native anadromous fisheries would be restored to pre-dam conditions. The terrestrial and aquatic Elwha River valley ecosystem, subtidal and nearshore marine area at the river mouth, natural sediment transport regime, 715 acres of terrestrial wildlife habitat, and access to many cultural resources including several sites sacred to the Lower Elwha Klallam Tribe would be restored. In addition, a restored and uninterrupted river recreation corridor and increased long-term economic health for both the local community and tribe would result.

Although it is commonly believed that those salmon and steelhead populations in Olympic Peninsula rivers that are depressed cannot be restored, this is not true. Elwha River native stock or closely related sources of all 10 runs of salmon and seagoing trout are available. Anadromous fish do experience some stress from fishing and other factors, such as warming caused by El Niño, in their marine environment; but, data from North Coastal rivers with good quality habitat show spawning fish exceed agency goals in most years.

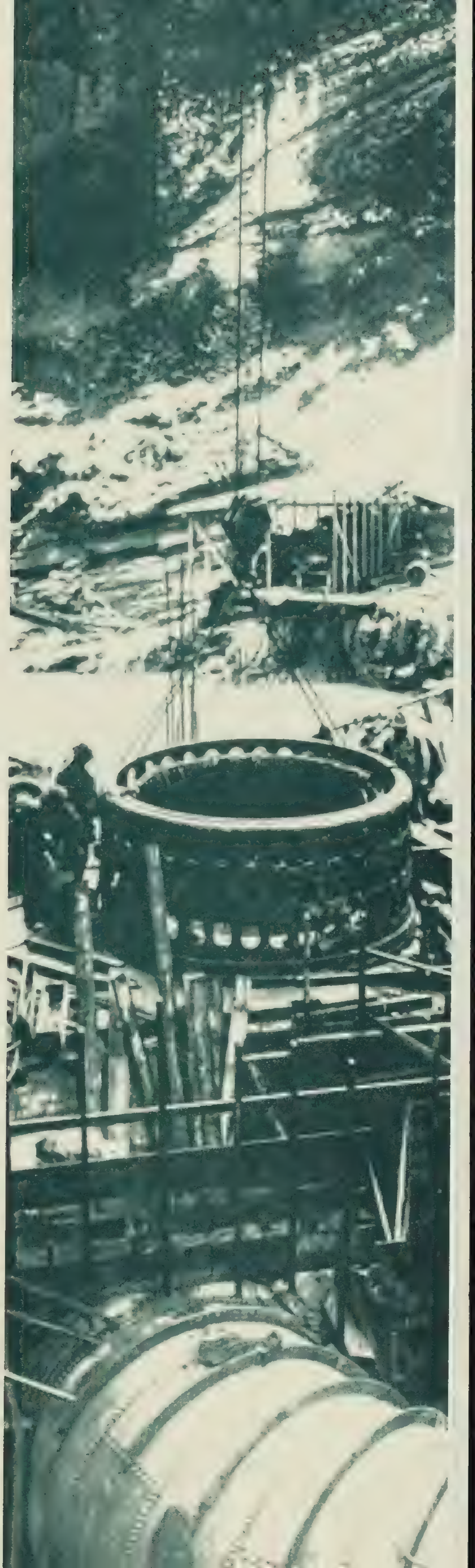
The destruction of the species' freshwater habitat — not overfishing — is primarily responsible for declines of specific runs. Agricultural, residential, and industrial development, as well as logging, roads, and recreational use, send sediment and pollutants into spawning rivers. Surface water withdrawals, channeling rivers for flood protection and elimination of estuary habitat, have also added to habitat degradation for anadromous fish. Dams that totally or partially block upstream and downstream fish migration from spawning grounds, such as those on the Elwha, have had major impacts on salmon and seagoing trout populations.

When completed in 1914, the Elwha Dam immediately eliminated 93% of the historic freshwater habitat for the river's native anadromous fish species. Since the vast majority of the Elwha drainage is within Olympic National Park and protected by preservation policies, removing the dams would immediately return this largely unaltered habitat to these species. Interior estimates that more than 380,000 salmon and steelhead would occupy the river after the dams were removed and restoration complete.

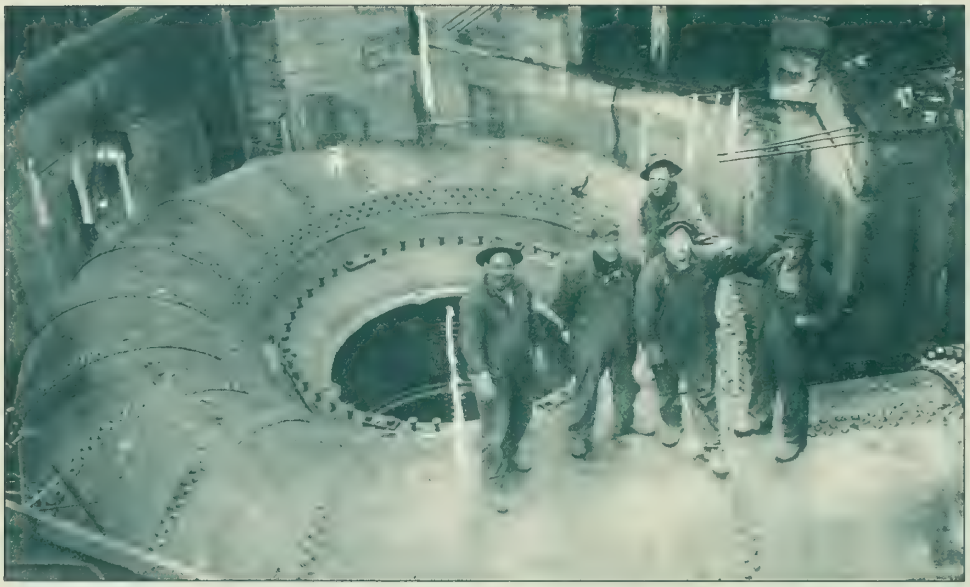
These fish, which were an integral part of the Elwha River valley ecosystem, would furnish a missing link for the restoration of that ecosystem. The dead and dying salmon, as well as juveniles, would fill the river throughout the year, providing a dependable and constant source of prey and river nutrients. Insect and aquatic invertebrate production would return to pre-dam levels, providing a base for the river's aquatic food chain. More than 22 native wildlife species would benefit when their prey source was reestablished.

Irreversible and Irretrievable Commitments of Resources

This section is meant to articulate any resources which would be lost either temporarily (such as the logging of a forest which will grow back) or permanently as a result of taking action. The resources permanently lost if action were taken as proposed would be an average annual generation of 172 gigawatt hours of hydroelectric power, the project facilities, and the two reservoirs. The projects are considered historically important because they represent early hydropower developments. Inventorying and recording the dam and power plant features in the Historical American Engineering Records would mitigate this loss. Recreation and wildlife habitat associated with the reservoirs also would be permanently lost. Short-term impacts, from six months to three years, on wildlife habitat, fisheries habitat, and water quality would also ensue from the release of sediment and construction noise.



Consultation and Coordination



Previous page: Setting of generator on building base, 1921. (Daishowa/ James River Company photo)

Penstock steel pipe and steel workers in bottom of power house, no date. (Clallam County Historical Society)

Consultation and Coordination

History of Public Involvement

The Federal Energy Regulatory Commission indicated its intent to write an environmental impact statement on whether to issue licenses for the Elwha and Glines Canyon dams by a Notice of Intent in the Federal Register on August 17, 1989. Formal scoping, or the early effort to involve agencies and the general public, was initiated in December 1989. Commission staff contacted interveners, state and federal agencies, Native American organizations, and members of the public who could provide input on the document. Two public scoping meetings were held in the state of Washington to identify issues and solicit public comments. After review of the comments, the commission wrote a scoping document that identified objectives, issues, and alternatives including **Dam Retention** (described in FERC 1993) and the **No Action** alternative. The No Action alternative was later eliminated as unreasonable.

A draft environmental impact statement was prepared by the Federal Energy Regulatory Commission and distributed to affected agencies and interested members of the public in February 1991; its Notice of Availability was published in the Federal Register March 1, 1991. Comments on the draft environmental impact statement were reviewed and responded to in a two-volume document that normally would have been the final environmental impact statement.

Prior to release of the final environmental impact statement, in October 1992, congress enacted Public Law 102-495, The Elwha River Ecosystem and Fisheries Restoration Act. Under the act, the secretary of the Department of the Interior was directed to study ways to restore the native anadromous fisheries and ecosystem of the Elwha River. The act stayed the licensing process for both dams until the required studies were completed. The Department of the Interior requested that the Federal Energy Regulatory Commission environmental impact statement be forwarded to the Department of the Interior to be used as supplementary information when preparing the study. The commission's environmental impact statement was then finalized as the *Draft Staff Report*, dated March 1993, and released to Congress and the Department of the Interior. The final report and response to comments were not released to the general public.

The *Elwha Report*, mandated by Public Law 102-495, was made available for public review and comment from October 4 to November 8, 1993. An open house to discuss the *Elwha Report*, held during October 1993 in Port Angeles, was attended by approximately 200 persons. Staff from the agencies responsible for preparing the report (departments of the interior and commerce and the Lower Elwha Klallam Tribe) answered questions and recorded attendees' comments. The report was completed in January 1994 and submitted to Congress in June 1994. Portions of the report were modified based on comments that were received. Appendix M of the final document contains direct responses to public comments.

On August 1, 1994, a Notice of Intent was placed in the Federal Register describing the National Park Service's intention to prepare two environmental impact statements. The first environmental impact statement, which relied heavily on both the FERC *Draft Staff Report* (adopted most of it) and the *Elwha Report* (incorporated the entire report by reference), examined whether to remove the dam(s). This environmental impact statement has been prepared to analyze a range of alternative ways to remove the dams and manage the sediment trapped behind them. The National Park Service is the "lead agency" responsible for the coordination and writing of both environmental impact statements. The US Bureau of Reclamation, US Bureau of Indian Affairs, US Fish and Wildlife Service, US Army Corps of Engineers, and the Lower Elwha Klallam Tribe are cooperating agencies. Members from each of these agencies make up the "EIS team." The agencies conducted the bulk of the studies required for the environmental impact statements and have provided extensive review and comments on both.

The first draft environmental impact statement, *Elwha River Ecosystem Restoration* released for public review and comment in October 1994, analyzed a range of alternatives to restore the Elwha River anadromous and native fisheries and ecosystem: (1) No Action, (2) removing either of the dams and providing fish passage measures on the remaining dam, (3) retaining both dams with fish passage measures on both, and (4) removing both dams. Public workshops to receive comments on the draft environmental impact statement were held in Seattle and Port Angeles in November 1994. In addition, interested parties were invited to submit written comments during the 60-day public review and comment period.

This document is the second of the two environmental impact statements prepared to analyze native anadromous fisheries and ecosystem restoration on the Elwha River. It is entitled *Elwha River Ecosystem Restoration Implementation Environmental Impact Statement.* Public scoping sessions for this document were held in conjunction with the public meetings for the draft of Interior's first, or programmatic environmental impact statement *(Elwha River Ecosystem Restoration Environmental Impact Statement).*

This environmental impact statement does not evaluate partial dam removal or other alternatives; this was done as part of the previous programmatic environmental impact statement. The focus of this implementation document is the safe, environmentally sound, and cost-effective removal of both Elwha and Glines Canyon dams. After beginning with a full range of options for dam removal and sediment management, the major sources of impact in this project, the EIS team analyzed whether any technical, safety, cost or environmental limitations made them infeasible (see Alternatives Considered but Rejected section in the Alternatives chapter). If two alternatives had identical environmental impacts and were equally technically feasible and safe, the less expensive of the two was selected for further analysis. One set of dam removal and two of sediment management remained after these criteria were applied. The sediment management scenarios are River Erosion and Dredge and Slurry Alternatives. The No Action Alternative was also included for comparison purposes.

To make these alternatives environmentally sound, mitigation for: surface and groundwater users, downstream residents who may experience slight increases in frequency of flooding, anadromous fish (both hatchery produced and native), nesting marbled murrelets (a species listed as threatened on the Endangered Species Act list that may be present in the project area), native vegetation affected by the invasion of nonnative weeds and plants, slopes now inundated by reservoirs that may require revegetation, marine life impacted by the discharge of sediment from the slurry pipeline, individuals experiencing increased noise or dust from the construction sites, cultural resources, workers and downstream resident's safety during dam removal, and local residents and visitors affected by closing the Elwha subdistrict in Olympic National Park has been analyzed and proposed in this document. Mitigation that is required as part of the Elwha Act has been built into the alternative and other mitigation, although not specifically required by the act, has been recommended by the EIS team (see Alternatives chapter for a listing of specific mitigation measures and individual impact topic sections for additional details).

Public meetings and a 60-day review and comment period on this draft document will be part of the public input process for this EIS.

Scoping Issues

Oral and written comments on scoping issues for the Implementation EIS were received at the public meetings held in Port Angeles and Seattle on November 14 and 15, 1994. Written comments were also received during the 60 day public comment period on first programmatic environmental impact statement. The EIS team responded to many of the scoping issues in the final version of the programmatic environmental impact statement, released in June 1995. Some were eliminated as less important; a summary of these issues and issues raised and subsequently eliminated by the EIS team is presented in the Purpose and Need chapter, "Issues dismissed from further analysis" section. Issues and concerns retained for further analysis in the implementation EIS are identified in table 3 in the Purpose and Need chapter in a section entitled "Issues and concerns."

Public Comment Period

The public comment period for this environmental impact statement will last for 60 days. Readers are encouraged to send their comments on the draft environmental impact statement to **Sarah Bransom, National Park Service (DSC-RP), Elwha River Restoration Project, P O Box 25287, Denver, CO 80225-0287, phone (303) 969-2210.** Dr. Brian Winter, Olympic National Park (360) 452-0302 may also be contacted for comments or questions regarding this EIS.

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Roger Fernandes, drawings on pages 7, 145, 146, 158, 166, 307, 339, 341

Linda M. Feltner, drawings on pages 21, 27, 62, 127, 129, 130, 132, 133, 142, 250, 273, 281, 282, 288, 346

Agencies and Organizations That Received Copies of the Draft Implementation Environmental Impact Statement

Federal Department, Agencies, Committees and Laboratories

Department of Energy
Department of the Interior
Environmental Protection Agency
Federal Emergency Management Agency
Federal Energy Regulatory Commission
General Accounting Office
House Fisheries and Wildlife Committee
House Natural Resources Staff
Idaho National Engineering Laboratory
National Academy of Sciences
National Biological Service
National Marine Fisheries Service
National Oceanic and Atmospheric Administration

Federal Department, Agencies, Committees and Laboratories (continued)

National Park Service
  LBJ National Historic Park
  Mount Rainier National Park
  Olympic National Park
  St. Croix Scenic Riverway
  Yosemite National Park
Natural Resources Conservation Service
President's Council on Sustainable Development
Senate Appropriations Committee
Senate Energy & Natural Resources Committee
U.S. Army Corps of Engineers
U.S. Bureau of Indian Affairs
U.S. Bureau of Land Management
U.S. Bureau of Mines
U.S. Bureau of Reclamation

Federal Department, Agencies, Committees and Laboratories (continued)

U.S. Coast Guard
U.S. Congress Office of Technical Assessment
U.S. Fish and Wildlife Service
U.S. Forest Service
    Columbia Gorge
    Olympic National Forest
U.S. Geological Survey
U.S. Office of Surface Mining
U.S. Office of the Regional Solicitor
Washington Area Power Administration

Tribal Governments and Organizations

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Confederated Tribes of the Umatilla Reservation
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Elwha Klallam Tribe
    Lower Elwha Fisheries
    Elwha Tribal Council
Jamestown S'Klallam Tribe
Makah Indian Tribe
Northwest Indian Fisheries Commission
Point No Point Treaty Council
Port Gamble S'Klallam Tribe
Puyallup Indian Tribe
    Puyallup Fisheries Department
Quileute Indian Tribe
Skokomish Indian Tribe
Shoshoni Bannock Tribe
    Shoshoni Bannock Fisheries Department
Small Tribes Organization of Western Washington
Yakama Nation

States Agencies and Organizations

State of California
    Department of Fish and Game
State of Michigan
    Department of Natural Resources
    Fisheries Division
State of Montana
    Environmental Quality Control
State of New York
    Power Authority
State of Oregon
    Department of Fish and Wildlife
    Natural Resources Council
State of Washington
    Department of Community Development
    Department of Ecology
    Department of Fish and Wildlife
    Department of Health
    Department of Natural Resources

States Agencies and Organizations (continued)

(State of Washington continued)
    Department of Trade and Economics
    Department of Transportation
    Governor's Office
    Historic Preservation Office
    Parks and Recreation Commission
    State Energy Office
    Water Power Authority
State of Wisconsin
    Department of Natural Resources

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Honorable Slade Gorton
Honorable Richard Hastings
Honorable Jim McDermott
Honorable Jack Metcalf
Honorable Patty Murray
Honorable George Nethercutt
Honorable Linda Smith
Honorable Randy Tate
Honorable Rick White

County and Local Governments

City of Forks
    City Council's Office
    City Planner / Attorney
City of Port Angeles
    City Attorney's Office
    City Council's Office
    City Light
    City Manager
    Planning Department
    Utilities Department
City of Sequim
    City Council's Office
    Planning Department
Clallam County
    Commissioner's Office
    County Administrator
    County Attorney's Office
    Department of Community Development
    Department of Roads and Public Works
Clallam County Public Utility District #1
    Commissioner's Office
    General Manager
Port of Port Angeles
    Commissioner's Office
    Executive Director

County and Local Governments (continued)

- Seattle
  - City Light
  - Water Department
- Snohomish County
  - Surface Water Management
- Tacoma
  - Public Utilities

Organizations and Business

Adele McCall
Allegheny Electric Conservative, Inc.
American Rivers
American Whitewater Affiliation
Appalachian Mountain Club
Aquaculture Research Institute
Battelle Northwest
Beak Consultants
Bonneville Power Administration
Buchanan Ingersoll
Carolina Power and Light Company
Century 21 Harbor Lights
Chinook Northwest Inc.
Clallam County - Sekiu Chamber of Commerce
Clallam County Grange
Clallam County Historical Society
Clallam County Public Utility District #1
Coastal Consultants, Inc.
Columbia Basin Fish & Wildlife Authority
Columbia Gorge Audubon Society
Common Sense Resource League
Crescent West Inc.
Cuttler and Stanfield
Daishowa America Inc.
Decision Data
Dorsey & Whitney
Dry Creek Grange #646
Dry Creek Water Association, Inc.
EA Enginering
Elwha Place Homeowners' Association
Environmental Impact Services
Environmental Planning Strategies
Federation of Fly Fishers
First Federal Savings and Loan
Fish Pro
Fletcher Far Ayotte
Forks Chamber of Commerce
Forks High School
Foster Wheeler Environmental
Friends of the Cowlitz
Friends of the Earth
Friends of the Eel
Friends of the Elwha
Gehrke's Gink
Glen Canyon Environmental Studies
Grant County Public Utilities District

Organizations and Business (continued)

Graystone
Greater Ecosystem Alliance
Green Crow Partnership
Harza Engineering
HDR Engineering, Inc.
Hood Canal Environmental
Hung West & Associates, Inc.
Hydro-Triad Limited
Idaho National Engineering Laboratory
Idaho Rivers United
Indian Creek Campground
Infraspect
International Archeological Research Institute
International Rivers Network
IRN
James River Corporation
Jones & Jones
Jorgensen Engineering
King County Parks, Planning and Resources
Klahane Club
Lane & Lane Associates
Lipman Auto
Lighthawk
Log Cabin Resort
Mazamas
McGavick Graves Attorney at Law
Mendocino Environmental Center
Metamorphosis
Meyer Resources, Inc.
Montesano Vidette
NW Conservation Act Coalition
National Outdoor Leadership School
National Park Foundation
National Parks & Conservation Association
National Wildlife Federation
Native American Fish and Wildlife Society
Neahkanie Mountain
North Olympic Environmental Resource Center
North Olympic Land Trust
North Olympic Peninsula Visitor and Convention Bureau
North Olympic Salmon Coalition
North Peninsula Home Builders Association
Northrop, Devine and Tarbell
Northwest Chapter - Wilderness Watch
Northwest Economic Association
Northwest Hydraulics Consultants
Northwest Power Planning Council
Northwest Sportfishing Industry Association
Okanogan Resource Council
Olympic National Resources Center
Olympic Outdoor Sportsmen's Association
Olympic Park Associates
Olympic Park Institute
Olympic Peninsula Audubon Society
Olympic Raft & Guide Service

Organizations and Business (continued)

Olympic Rivers Council
Outside Connection
PacifiCorp
Pacific Fishery Management Council
Pacific Northwest Trail Association
Pacific Power and Light Company
Pacific State Marine Fisheries Commission
Pacific Rivers Council
Parametrix
Perkins Coie
Phelps Dodge Corporation
Port Angeles Chamber of Commerce
Port Angeles-Victoria Visitor Bureau
Portland General Electric
Port Townsend Chamber of Commerce
Preston, Gates and Ellis
Preston, Gates, Ellis & Raivela Meeds
Puget Sound Power and Light Company
Puget Sound Water Quality Authority
Radin and Associates, Inc.
Rainier Evergreen Inc.
Rayonier Inc.
Recreational Equipment Inc.
Redwoods Science Lab
Rescue Elwha Area Lakes
Riddell, Williams, Bullitt & Walkinshaw
Ridolfi Engineering & Associates
Rio Grande Restoration Project
Rivers Council of Washington
Rivers Network
Robbin B. Sotir & Associates
RUST Environment & Infrastructure, Inc.
Save Our Wild Salmon Coalition
SCS Engineers
Seattle Aquarium
Seattle Audubon Society
Sequim Chamber of Commerce
Shapiro and Associates
Sierra Club
Sierra Club Legal Defense Fund
Simpson, Thacher & Bartlett
Sol Duc Hot Springs Resort
St. John's River Water Management District
Stone and Webster Engineering Corporation
Summit Technology
TQ NEPA
Terrestrial Ecology
Tetra Tech
The Mountaineers
The Rockey Company
The Trust for Public Land
The Wilderness Society
Triangle and Associates
Trout Unlimited
Trumpeter Swan Society
Twanoh Group Sierra Club

Organizations and Business (continued)

U.S. Savings Bank of Washington
Van Ness Feldman
Washington Appellate Defender Association
Washington Environmental Council
Washington Sea Grant Program
Washington State Grange
Washington State Sportsman's Council
Washington Wilderness Coalition
WEC
Wells National Esturaine Kraver & Quinn Research Reserve
Roy F. Weston, Inc.
Wilkinson Barker
Wise Use Movement
Woodward Clyde
Wrong Mountain Wildlife Preserve

Libraries

Aberdeen Timberland Branch Library
Bellevue Branch Library
Bremerton Branch Library
Clallam Bay Branch Library
Colorado State University
Everett Public Library
Forks Branch Library
Holland Library - Washington State University
Hoodsport Timberland Branch Library
Kirkland Branch Library
Kingston Branch Library
Mansfield Library
Port Angeles Branch Library
Redmond Branch Library
Renton Public Library
Sequim Branch Library
Port Townsend Public Library
Seattle Public Library
Tacoma Public Library
University of Washington
Washington State Department of Fish & Wildlife Library
William G. Reed Branch Library

Academic Institutions

Albion College
Central Washington University
Charles Wright Academy
Colorado State University
Ferris State University
Humboldt State University
Kansas State University
Michigan State University
Northwestern University
Oregon State University

Academic Institutions (continued)

Peninsula College
Pitzer College
St. Johns University
The Evergreen State College
University of California at Davis
University of Montana
University of Oregon
University of Washington
University of Wyoming
Washington State University
Western Washington University
Williams College

Newspapers

Associated Press
Bellingham Herald
East County News
Everett Herald
Forks Forum
High Country News
Hydrowire Newsletter
Jimmy Come Lately Gazette
Land Use Chronicle
McClatchy Newspaper
Montesano Vidette
Out West Newspaper
Peninsula Daily News
Peninsula Gateway News
Port Townsend Leader
San Francisco Chronicle
Seattle Post Intelligencer
Seattle Times
Sequim Gazette
Shelton-Mason County Journal
Tacoma News Tribune
The Citizen News
The Daily News
The Daily World
The Olympian
The Sun
USA Today
UPI

Magazines

Backpacker
Current
National Fisherman
National Geographic Society
New York Times Magazine
Outside Magazine
Pacific Northwest Magazine
Peninsula Magazine
Popular Mechanics
Seattle Weekly
Signpost Magazine
Sunset Magazine
The Christian Science Monitor
U.S.A. Weekend Magazine

Radio/TV Stations

CNN
KSOH-FM
KAPY
KAYO Aberdeen
KBAM Radio
KBWK Radio
KGHO
KGY Radio
KING TV and Radio
KIRO TV and Radio
KJR Radio
KKMO Radio
KMAS
KMPS Radio
KOMO Radio and TV
KONP
KPLU
KQEU
KRKO
KSTW TV
KUOW
KVAC/KLLM
KVOS TV
KXLY TV
KXRO/KDUX
National Public Radio
Northland Cable News (NCN)
Seattle / King County News Bureau
WNYC News

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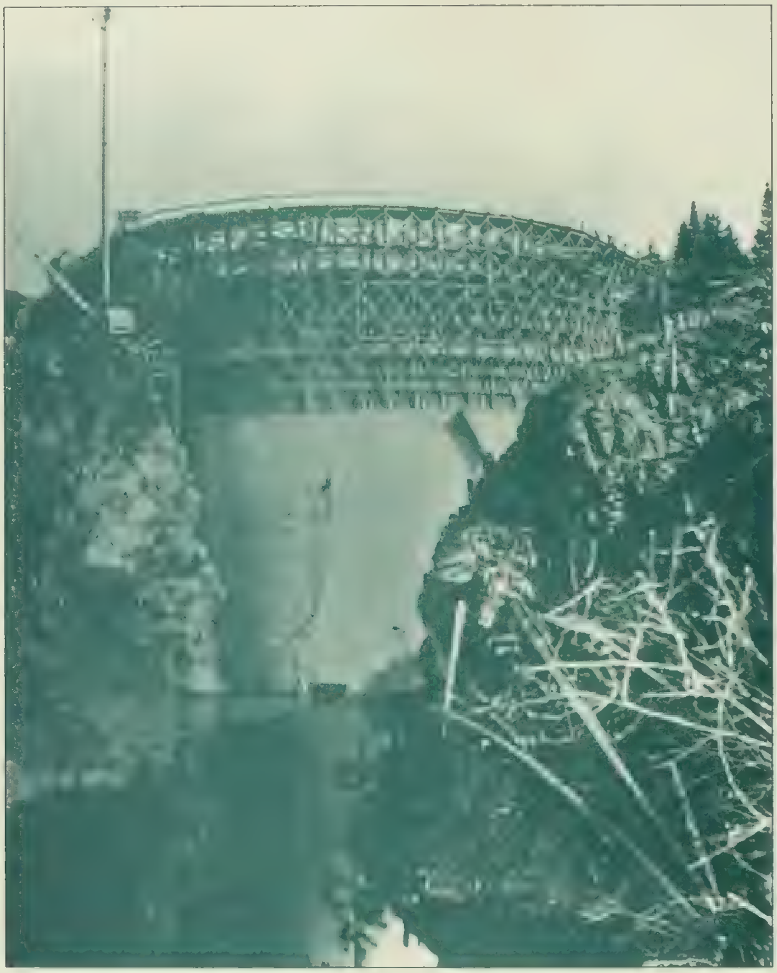

Previous page: Elwha River—Island Camp, May 27, 1907. (Asahel Curtis photo, Washington State Historical Society)

Glines Canyon Dam from Lake Mills, without water. (Daishowa/James River Company photo)

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Glossary and Acronym List

A

accipiter - Short-winged, long tailed, forest dwelling birds of prey. There are three in the project area; Cooper's hawk, sharp shinned hawk, and goshawk.

adfluvial - Fish that reside mostly in lakes, but spawn in rivers.

affected environment - Existing biological, physical, social, and economic conditions of an area that are subject to change, both directly and indirectly as a result of a proposed human action.

agglomeration site - The surface (such as a lamella plate) where suspended particles can efficiently collect and form a larger particle. During processes such as water treatment, these larger particles (called floccules) settle out of solution more rapidly than individual particles would.

aggradation - Process of raising the level of a streambed, floodplain or sandbar by deposition of sediment.

alluvium - Sediments that are transported and deposited by streams and rivers such as clay, silt, sand, gravel, cobbles, and boulders.

amphipod - Order of crustaceans such as shrimp.

anadromous fish - Species of fish such as salmon, which hatch in freshwater, spend a large part of their lives in the ocean, and return to freshwater to reproduce.

angler - A person who fishes with a rod and reel.

armoring - Progressive removal of finer grained sediments from a streambed leaving a layer of coarser sediment that is less easily eroded.

artificial constant head - Hydraulic head maintained by artificial means.

attenuate - To weaken or reduce the force of something such as flood waters.

avoided costs - Money that is not spent because something is done differently.

B

bedload - Coarse sediment (sand, gravel, cobble or rock fragments) transported along the bottom of a stream and frequntly in contact with it.

biomass - The total amount of living organisms of one or more species in a particular area or environment, often expressed as weight per unit of volume or area.

BOR - Bureau of Reclamation, a federal agency in the Department of the Interior.

brackish water - Where saltwater and freshwater mix as in an estuary.

brood - Young animals or fish born or hatched at one time.

broodstock - Animals or fish with a common origin that are kept for breeding.

brood year - Animals or fish born or hatched during one year.

butterfly valve - A mechanical device used to control the flow of water in a pipeline. This valve contains a circular leaf which is located in the center of the pipe and rotates 90 degrees to regulated the flow of water in the pipeline.

C

caisson - Watertight structure in which underwater structures are housed.

capacitor - An electric circuit element used to temporarily store an electrical charge.

cfs - Cubic feet per second, a unit of measurement for flowing water. A cubic foot of water passing a reference point in 1 second of time.

channel storage - Sediment or water that is temporarily stored in between the banks of a river channel.

COE - U.S. Army Corps of Engineers, a federal agency in the Department of Defense.

cofferdam - Temporary dam allowing dewatering of a portion of a river or lake for construction purposes.

conductance - Measure of a material's ability to conduct an electrical charge.

constant head - The force or pressure acting on a system that does not vary. This force or pressure is applied from a constant water level.

creel survey - Survey of anglers to determine the type species and number of fish captured in a specific area (stream or lake) over a specified time period.

D

diatoms - Individual or group of one celled algae.

discount rate - The interest deducted in advance in purchasing, lending, or selling something.

DOI - Department of the interior, the federal department preparing this environmental Impact statement to analyze the impacts of restoring the anadromous fisheries and ecosystem of the Elwha River. The National Park Service is the lead DOI agency in the preparation of this EIS.

E

ecology - The study of the interrelationships between organisms and their environments.

ecosystem - A community of living organisms interacting with one another and with their physical environment, such as a forest, pond or estuary.

ethnohistory - The study of the past ways of life of a group of people or culture.

Eicher screens - Experimental technology to minimize fish injuries that places a screen within a penstock and uses water velocity to carry juvenile salmonids past the screen and into a bypass pipe, thus avoiding turbines.

EIS - Environmental Impact Statement. The National Environmental Policy Act of 1969 requires that an environmental impact statement be prepared to evaluate the potential environmental affects of major federal actions. An EIS identifies and analyzes activities that might affect the human and natural environment.

electric weir - A structure that uses electric current to prevent entry by fish into an area.

EPA - Environmental Protection Agency.

epicenter - Location on the surface of the earth above where an earthquake originates.

escapement - Adult fish that escape fishing gear to migrate upstream to spawning grounds.

estuary - Area near the mouth of a river where fresh and saltwater intermix.

Euro-Americans - Americans of European descent.

extirpate - Eradicate, often referring to wildlife species no longer present in an area, extinct.

F

fault - Break in the Earth along which movement occurs. Movements along faults produce earthquakes.

FERC - Federal Energy Regulatory Commission, the federal agency authorized to issue licenses to operate and maintain nonfederal hydroelectric projects. This EIS and the first Elwha EIS are tiered off of the FERC *Draft Staff Report* and have incorporated most of the document by reference.

fiduciary - Relating to or involving something held in trust for another.

fine-grained sediments - Clay and silt sized particles that are smaller than 0.0030 inches (0.075 mm) in size.

fingerling - Small fish ranging in size from 1 to 3 inches.

fish ladder - An ascending structure of intervening pools of water that is built to allow fish to migrate upstream.

flocculants - Chemicals that cause small particles suspended in a solution to form clumps or masses precipitated from a solution.

floodplain - Land adjacent to a river that is periodically subject to flooding.

food chain - The succession of organisms in a community in which food energy is transferred from one organism to another as each consumes a lower member and in turn is consumed by a higher member.

forebay - Impondment immediately above a dam or hydroelectric plant intake structure.

fry - Early swiming stage of young fishes, between the egg and fingerling stages.

FWS - U.S. Fish and Wildlife Service, a federal agency in the Department of the Interior.

G

gauging station - Specific location on a stream where systematic observations of hydrologic data are obtained through mechanical or electrical means.

geotextile - Wide range of synthetic fabrics used to modify soil and foundation characteristics during earth control and drainage.

Gwh - Gigawatt is a unit of electrical power, one thousand times larger than a megawatt and one billion times larger than a watt.

gunite - Mixture of cement, sand, and water applied as a sealing agent to prevent weathering of things such as mine timbers and roadways.

H

HABS - Historic American Buildings Survey. If buildings are removed during dam removal, documentation would include a history of the building, measured drawings of designated features, photographs, and archival copies of important engineering records and drawings, to help minimize the loss of the buildings.

HAER - Historic American Engineering Record. If the dams are removed, documentation would include a history of the project, measured drawings of designated features, photographs, and archival copies of important engineering records and drawings to help minimize the loss of the dams.

haulout site - Resting area onshore for wildlife species such as Stellar sea lions

hydraulic gradient - The slope of the surface of open or undergroundwater.

hydroelectric - Generating electricity by conversion of the energy of running water.

I

indigenous - People or animals that live or naturally occur in a specific area or environment.

infiltration gallery - One or more horizaontally laid screens placed in permeable alluvial materials, either adjacent to a water body or beneath its bed. Usually installed to supply water from aquifers where the hydraulic conductivity is large but the transmissivity is severely limited because the deposits are thin.

inholding - Parcel of land surrounded by property owned by another.

in-line filtration - A water treatment filter (mechanical screening device) installed on the main water supply line.

intertidal - The area between the extremes of high and low tide.

J

juvenile - Refers to any fish that is not adult. It is the life stage of salmon and trout living in freshwater before entering the ocean.

K

kokanee - Landlocked sockeye salmon.

KWh - A kilowatt is a unit of electrical power equal to 1,000 watts of power applied over one hour.

KVA - (Kilo Volt Ampere) - a unit of electrical power equal to about 1.3 horsepower.

L

LEKT - Lower Elwha Klallam Tribe.

levee - A dike or embankment of earth or concrete that is used to prevent water from overflowing the river channel during times of flooding.

levels of service (LOS) - Level of service is a qualitative assessment of intersection operations based on the average delay (in seconds) by vehicles. Delay is a measure of driver frustration, fuel consumption, and lost travel time.

M

magnitude - Total energy released by an earthquake. Magnitudes in this document are measured on a *moment magnitude scale,* the standard scale now used by seismologists. It accurately measures earthquake strength directly related to seismic energy release and unlike the Richter scale, is accurate even for largescale earthquakes.

mainstem - Main course of a stream.

maximum credible earthquake (MCE) - The earthquake(s) that would cause the most severe ground motions or foundation displacements possible for the site based on specific seismotectonic characteristics (magnitude and recurrence interval) of the area.

maximum probable flood - The most severe flood that is considered reasonably possible at a site as a result of hydrologic and metereologic conditions.

meander - Winding course of a river.

mill - Monetary cost and billing unit used by utilities, equal to 1/1000 of a U.S. dollar.

mitigation - Activities that will avoid, reduce the severity of, or eliminate an adverse environmental impact.

morphology - The three dimensional characteristics or form of a feature such as a river channel.

MWh -Megawatt, a unit of electrical energy equla to one million watt-hours of electrical power.

N

native anadromous fisheries - The populations of anadromous fish that historically inhabited a river.

NEPA - National Environmental Policy Act, a 1969 federal law that requires the consideration of environmental effects of proposed federal actions.

nonpoint - Refers to the source of sediment or pollution (such as runoff from a field) that cannot be linked to a discrete, identifiable source.

NPS - National Park Service, a federal agency in the Department of the Interior.

NTU - Nephelometric turbidity unit is a measurement of how intensely light is scattered by particles in the water.

O

oligotrophic - Body of water with low biological productivity.

outmigration - The movement of juvenile fish from freshwater to the sea.

outplanting - Distributing of fish to suitable habitat.

outwash - Accumulation of material such as sand and gravel removed from a glacier by meltwater streams and deposited in front of the margin of an active glacier.

P

parts per million (ppm) - A dimensionless concentration unit used to report weight-per-weight or volume-per-volume ratios. For practical purposes, milligrams per liter and parts per million are nearly equivalent for concentrations up to 10,000 parts per million.

palustrine - Nontidal wetlands dominated by trees, shrubs, persistent emergent vegetation, and emergent mosses or lichens, or nonvegetated wetlands less than 20 acres in size.

passerines - Songbirds.

penstock - An intake pipe from a water source to a hydroelectric turbine or powerhouse.

polychlorinated biphenyls (PCBs) - Hazardous chemical compound that may be present in electrical power transformers.

post tension anchors - A method of providing stability by holding components of a structure together using steel cables or tendions.

powerplant - Structures that house turbines, generators, and associated control eqipment.

PSD - (air quality) - Prevention of significant deterioration.

R

Ranney well - A method of collecting groundwater through buried perforated pipes often placed under riverbeds.

raptors - Birds of prey such as red tailed hawks and bald eagles.

real costs - Baseline costs that do not account for inflation.

recurrence interval - Sometimes called return times, it is the number of years between occurences of an earthquake of a given magnitude in a particular area.

red tide - A bloom of microscopic marine organisms (various dinoflagellates). Shellfish eaten during red tide events can be poisonous to humans.

remediate - To correct or fix something.

residualism - Typically refers to anadromous trout or salmon juveniles that remain in fresh water instead of migrating to the ocean.

riparian - Typically refers to vegetation found along waterways and shorelines that is adapted to moist growing conditions and occasional flooding.

riprap - Large angular stones that are used to build or strengthen riverbanks, and structures such as dikes, levees and spits.

run-of-the-river - Natural conditions in a river where the flow of water (discharge) has not been altered by sturctures such as dams.

river stage - The elevation of a water surface above or below an established refernce level, such as sea level, same as water surface elevation.

S

salmonid - Fish within the family Salmonidae, e.g. salmon and trout.

seiche - Sloshing of water in an enclosed basin such as a lake that is caused by an earthquake, similar to a tidal wave in the ocean.

seismic - Ground movements caused by earthquakes and other activities.

self-sustaining - Capable of maintaining oneself independently.

sessile - Organisms that are permanently attached or fixed to the bottom or substrate.

setback levee - A levee that is located away from a stream or river, typically to minimize impacts to the floodplain.

shoals - Shallow area in a body of water.

sluiceway - An outlet facility in a dam usually located low in the reservoir to allow for the flushing of sediments through the reservoir.

smolt - A young anadromous salmonid migrating downstream that has undergone the physiological changes necessary to survive in salt water.

spawn - The deposition and fertilization of eggs in organisms such as salmon and trout.

spawning gravels - Gravel of suitable size and shape in a stream where salmonids lay their eggs.

species - A group of individual plants or animals (including subspecies and populations) that have have common characteristics and interbreed.

spillway - Overflow channel of a dam.

subduction - Long narrow zone, usually along a continental margin (such as the Pacific coast) where a crustal plate on the Earth's surface descends beneath another plate.

substrate - Surface upon which plants or animals live or grow.

subtidal - Area of water below the low tide level.

successional forests - Stages of a forest that evolve from bare ground to climax community.

surge tank - A storage tank on a pipeline which has a free water surface which prevents damaging pressures during operation of the pipeline.

suspended sediments - Materials such as clay, silt, and sand that are carried in suspension by moving water, free from contact with the stream bed.

T

tailrace - The region of high velocity water flow below the turbine discharge in a hydroelectric facility.

thalweg - Line connecting the deepest points along a riverbed.

thrust block - A large mass of concrete that serves as the foundation for a concrete arch dam and is designed to accept loads transfered from the arch dam.

till - Unlayered glacial deposit composed of clay, sand, rocks, and gravel.

transformer - Device that changes electrical current in a primary circuit into variations of current and voltage in another unit, older transformers commonly leaking PCBs, a hazardous chemical.

transmissivity - A measure of the flow characteristics of an aquifer (an underground water bearing formation).

trashrack - A grille-like structure on the inlet to a pipeline which prevents debris from entering the pipeline.

turbidity - The clarity of water expressed as nephlometric turbidity units (NTU) and measured with a calibrated turbidimeter. Increasing the turbidity of the water decreases the amount of light that can penetrate.

turbine - A rotary engine actuated by the flow of a fluid that is subject to pressure in contact with vanes located on a rotating shaft.

U

underyearling - animal that is less than one year old.

V

verdant - Vegetation covered with green growth.

W

watershed - The area drained by a river system.

water surface elevation - The elevation of a water surface above or below an established reference level, such as sea level, same as river stage.

wetland - Lowland area such as a swamp or marsh that is periodically saturated with water and supports vegetation adapted to wet areas.

Y

yearling - animal that is a year old.

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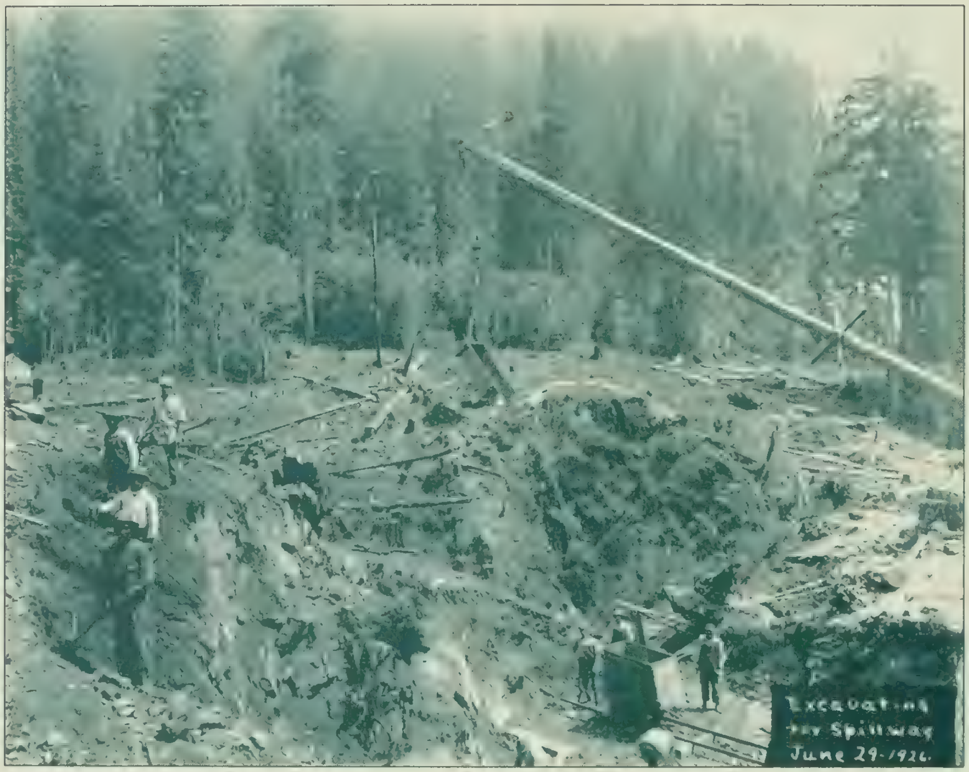
Appendixes



Previous page: Elwha River, no date. (Clallam County Historical Society)

Excavation for the Glines Canyon Dam spillway, 1926. (Daishowa/James River Company photo)

Appendix 1

Public Law 102-495 • Elwha Restoration Act

PUBLIÇ LAW 102–495–OCT. 24, 1992 106 STAT. 3173

Public Law 102–495
102d Congress

An Act

To restore Olympic National Park and the Elwha River ecosystem and fisheries in the State of Washington.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Elwha River Ecosystem and Fisheries Restoration Act. Conservation.

SECTION 1. SHORT TITLE.

This Act may be referred to as the "Elwha River Ecosystem and Fisheries Restoration Act."

SEC. 2 DEFINITIONS.

For the purposes of this Act:

(a) The term "Administrator" means the Administrator of the Bonneville Power Administration.

(b) The term "Commission" means the Federal Energy Regulatory Commission.

(c) The term "electric power" means electric peaking capacity or electric energy or both.

(d) The term "Elwha Project" means the Elwha River Hydroelectric Project, Federal Energy Regulatory Commission Project Number 2683, including appurtenant works and project lands, located on the Elwha River in Clallam County, Washington.

(e) The term "Glines Project" means the Glines Canyon Hydroelectric Project, Federal Energy Regulatory Commission Project Number 588, including appurtenant works and project lands, located on private and public lands both within and without the exterior boundaries of Olympic National Park on the Elwha River in Clallam County, Washington.

(f) The term "local industrial consumer" means the owner of the pulp and paper mill located on Ediz Hook in Port Angeles, Washington, that, on the date of enactment of this Act, receives and consumes the electric power produced by the Projects, or its successors or assignees.

(g) The term "local preference customer" means Port Angeles City Light.

(h) The term "owner" means the current owner of the Projects or its successors or assignees, but shall not mean the secretary, the United States, or any other entity acquiring title to the Projects or features thereof pursuant to the terms of this Act.(i) The term "Park" means Olympic National Park.

(j) The term "Project" or "Projects" means either or both the Elwha Project and the Glines Project, including project works and appurtenant lands.

(k) The term "project replacement power" means electric power delivered to the local industrial consumer to replace losses of electric power generation from the Projects following their acquisition by the secretary pursuant to this Act, in an amount not to exceed 172.088 gigawatthours of energy in any year.

(l) The term "secretary" means the secretary of the interior.

(m) The term "State" means the State of Washington, including its agencies and departments.

SEC. 3 ACQUISITION OF PROJECTS.

Effective date

(a) Effective sixty days after submission to the Congress of the report referred to in section 3(c), the secretary is authorized to acquire the Elwha and Glines Canyon Projects, and all rights of the owner and local industrial consumer therein, subject to the appropriation of funds therefor: *Provided,* That the secretary shall not acquire the projects unless he has determined pursuant to subsection (c) that removal of the Project dams is necessary for the full restoration of the Elwha River ecosystem and native anadromous fisheries and that funds for that purpose will be available for such removal within two years after acquisition.

(b) The consideration for acquisition of the Projects shall be $29.5 million and no more, to be paid by the secretary to the owner and local industrial consumer at the time of acquisition, and shall be conditioned on a release of liability providing that all obligations and liabilities of the owner and the local industrial consumer to the United States arising from the Projects, based upon ownership, license, permit, contract, or other authority, including , but not limited to, project removal and any ecosystem, fish and wildlife mitigation or restoration obligations, shall, from the moment of title transfer, be deemed to have been satisfied: *Provided,* That the United States may not assume or satisfy any liability, if any, of the owner or local industrial consumer to any federally recognized Indian Tribe nor shall such liability to the Tribe, if any, be deemed satisfied without the consent of such Tribe.

Reports

(c) The secretary shall prepare a report on the acquisition of the Projects and his plans for the full restoration of the Elwha River ecosystem and the native anadromous fisheries and submit such report on or before January 31, 1994, to the Appropriations Committees of the United States Senate and the United States House of Representatives, as well as to the Committee on Energy and Natural Resources of the Senate and the Committees on Energy and Commerce, Interior and Insular Affairs, and Merchant Marine and Fisheries of the Untied States House of Representatives. The report shall contain, without limitation:

(1) The precise terms of acquisition of the Projects, with an analysis of the costs, in addition to the consideration set out in section 3(b), and potential liabilities and benefits, if any, to the Federal Government resulting from the acquisition and all other actions authorized under this Act;

(2) Alternatives, in lieu of dam removal, for the restoration of the Elwha River ecosystem and the native anadromous fisheries and wildlife of the Elwha River Basin, consistent with the management plan of the Park, the rights of any Indian tribe secured by treaty or other Federal law, and applicable State law. The report shall include feasibility studies for each alternative considered and a definite plan for removal. Such definite plan shall include the timetable after conveyance for removal of the dams and

the plans for removal and disposal of sediment, debris, and other materials consistent with all applicable environmental laws and a detailed explanation of all costs of removal. In conducting the feasibility studies and in the preparation of the definite plan, the secretary is authorized to use the services of any Federal agency on a reimbursable basis and the heads of all Federal agencies are authorized to provide such technical and other assistance as the secretary may request. For each alternative considered, the secretary shall estimate total costs, environmental risks and benefits, the potential for full restoration of the Elwha River ecosystem and native anadromous fisheries, and the effect on natural and historic resources (together with any comments made by the Advisory Council on Historic Preservation for any properties which are listed, or eligible for listing, on the National Register of HIstoric Places).

(3) Specific proposals for management of all lands or interests therein acquired pursuant to this Act which are located outside the exterior boundaries of the Olympic National Park. The secretary shall specifically address the suitability of such lands, or portions there of, for addition to the National Wildlife Refuge System; National Park System; transfer to the Lower Elwha Klallam Tribe in trust for tribal housing, cultural, or economic development purposes in accordance with a plan developed by the Lower Elwha Klallam Tribe in consultation with the secretary; and development and use by the State. Upon acquisition, all lands and interests therein within the exterior boundaries of the Park shall be managed pursuant to authorities otherwise applicable to the Park. For the purposes of protecting the Federal investment in restoration, that portion of the river outside the Park on which the Federal Government will acquire both banks shall, upon such acquisition, be managed in accordance with the declared policy of section 1(b) of Public Law 90–542, except that modifications necessary to restore, protect, and enhance fish resources and to protect the existing quality of water supplied from the river are hereby authorized.

(4) Specific proposals and any Federal funding and the availability of that funding that may be necessary to protect the existing quality and availability of water from the Elwha River for municipal and industrial use from possible adverse impacts of dam removal.

(5) Identification of any non-Federal parties or entities, excluding Federally recognized Indian tribes, which would directly benefit from the commercial, recreational, and ecological values that would be enhanced by the restoration of the Elwha River ecosystem and fisheries, if the secretary believes that such parties or entities should assume some portion of the cost involved in the restoration, together with the specific cost-share provisions which the secretary deems necessary and reasonable.

(d) In preparing his report, the secretary shall consult with appropriate State and local officials, affected Indian tribes, the Commission, the Environmental Projection Agency, the secretary of Energy, the Administrator, the Pacific Northwest Power Planning Council, the secretary of Commerce, and the Advisory Council on Historic Preservation, as well as interested members of the public. In addition, the secretary shall afford an opportunity for public comment on the report prior to its submission to the Congress.

(e) Upon the appropriation of the sum provided for in section 3(b) for the acquisition of the Projects and the determination that dam removal is necessary, the owner and local industrial consumer shall convey to the United States, through the secretary, title to the Projects, including all property and all other rights and interests. Upon such conveyance and payment of the consideration as provided in section 3(b), and without further action by the United States, title shall transfer and vest in the United States. The owner and local industrial consumer shall be released from any further liability, to the United States, as provided in section 3(b), and the acquisition from the owner and local industrial consumer shall be deemed to be completed.

SEC. 4. ECOSYSTEM AND FISHERIES RESTORATION.

(a) Effective sixty days after submission of the report referred to in section 3(c) and following the conveyance in section 3(e), the secretary is authorized and directed, subject to the appropriation of funds thereof, to take such actions as are necessary to implement–

Effective date.

(1) the definite plan referred to in section 3(c)(2) for the removal of the dams and full restoration of the Elwha River ecosystem and native anadromous fisheries;

(2) management of lands acquired pursuant to this Act which are located outside the exterior boundaries of the Park; and

(3) protection of the existing quality and availability of water from the Elwha River for municipal and industrial uses from possible adverse impacts of dam removal.

(b) The definite plan referred to section 3(c)(2) must include all actions reasonably necessary to maintain and protect existing water quality for the City of Port Angeles, Dry Creek Water Association, and the industrial users of Elwha River water against adverse impacts of dam removal. The cost of such actions, which may include as determined by the secretary , if reasonably necessary, design, construction, operation and maintenance of water treatment or related facilities, shall be borne by the secretary. Funds may not be appropriated for removal of the dams, unless, at the same time, funds are appropriated for actions necessary to protect existing water quality.

(c) Nothing in this section shall be construed as an entitlement for which a claim against the United States may be made under the Tucker Act.

SEC. 5. PROJECT OPERATION AND REPLACEMENT POWER.

(a) Notwithstanding any other provision of law, neither the Federal Energy Regulatory Commission nor any other agency of the Federal Government shall have the authority or jurisdiction to issue a permanent license or similar order with respect to either Project prior to conveyance as provided in section 3(e), except that the Commission shall have jurisdiction under the Federal Power Act and is hereby authorized and directed to issue or maintain in effect annual licenses or authorizations for both Projects, authorizing continued operation of both Projects by the owner and local industrial consumer, such operation to be under such terms and conditions and in accordance with such practices as existed on September 1, 1992, until (1) the date the secretary has acquired title to the Projects or (2) if the secretary's report required in section 3(c) does not provide for dam removal, five years after the expiration of the current annual license or authorization then in effect, after which time the Commission shall have authority under the Federal Power Act to issue appropriate licenses with respect to such Projects to the extent the Commission has jurisdiction over such Projects under such Act on the date of enactment of this Act.

(b) To ensure the availability of adequate electric power supplies to the operating facilities of the local industrial consumer, the Administrator shall, following acquisition of the Projects pursuant to this Act, deliver all project replacement power required by the operating facilities of the local industrial consumer through the local preference customer at a rate equal to the priority firm rate, or the rate which is then the equivalent of the priority firm rate if that designation is no longer used by the Administrator, as such rate is fixed by the Administrator from time to time, without regard to any new large single load determinations or similar factors. The local industrial consumer shall pay the local preference customer for such project replacement power at the same rate as all other industrial consumers of the local preference customer.

(c) Upon conveyance of the Projects to the Untied States, the secretary shall maintain the dams in a safe condition for the period prior to their removal.

SEC. 6. LEASE OF FEDERAL LANDS.

(a) LEASE OF LANDS TO THE CITY OF PORT ANGELES.—After the secretary makes the determination to remove the dams and actually acquires the projects and funds are appropriated for such conveyance and removal, the secretary is authorized to issue a lease to the City of Port Angeles, Washington, for those lands situated on Ediz Hook, Clallam County, Washington, currently leased to the City under Lease No. DOT–CG123–4811–72, dated April 4, 1972, as amended, except for that parcel of land described in subsection (b)(2). Such lease shall be issued pursuant to the Act of June 14, 1926, as amended (43 U.S.C. 869), for a period of 99 years, beginning on a date to be determined by the secretary, without right of patent.

(b) LEASE OF LANDS TO THE LOWER ELWHA KLALLAM TRIBE.—

(1) After the secretary makes the determination to remove the dams and actually acquires the Projects and funds are appropriated for such conveyance and removal, the secretary is authorized to lease to the Lower Elwha Klallam Tribe that parcel of land situated on Ediz Hook, Clallam County, Washington, described in paragraph (2) for the purposes of the construction and operation of a tribal cultural facility, such as a longhouse or a museum, and associated interpretive and parking facilities. Such lease shall be issued pursuant to the Act of June 14, 1926, as amended (43 U.S.C. 869), for a period of ninety-nine years beginning on a date determined by the secretary, without right of patent.

(2) The parcel of land to be leased to the Lower Elwha Klallam Tribe is that parcel of land lying south of the existing roadway and extending southward to the southern boundary of the land currently leased to the city of Port Angeles (Lease No. DOT–CG13-4811–72, dated April 4, 1972, as amended) and beginning at the north-south line 200 feet east of the western boundary of Out Lot 6 and running easterly 600 feet to the north-south line 300 feet west of the eastern boundary of Out Lot 6.

(3) In addition to the general terms and conditions applicable under the Act of June 14, 1926, as amended (43 U.S.C. 869), the lease to the Tribe shall be subject to the following terms and conditions:

(A) There shall be public access to the beach along the south side of the parcel at all times.

(B) The City of Port Angeles shall have the right to construct and maintain a waterfront trail adjacent to the existing roadway along the north side of the parcel, the location of which shall be determined in conjunction with the secretary.

(C) Parking facilities on the parcel shall be open to the public at all times.

(4) In addition to the terms and conditions described in this section for

the leases to the City and the Tribe, the secretary shall incorporate by reference into each lease the Agreement entered into on August 11, 1992, between the City and the Tribe regarding the use of the adjacent leaseholds.

SEC. 7. TRIBAL LAND ACQUISITION AND DEVELOPMENT.

(a) After the secretary makes the determination to remove the dams and actually acquires the Projects and funds are appropriated for such conveyance and removal, the secretary is authorized to acquire by purchase, and hold in trust in reservation status for the benefit of the Lower Elwha Klallam Tribe, lands in Clallam County, Washington, for housing, economic development, and moorage for the Tribal commercial fishing fleet.

Appropriation authrozation.

(b) There is authorized to be appropriated an amount not to exceed $4,000,000 to carry out the land acquisition purposes of this section.

SEC. 8. SAVINGS.

(a) Nothing in this Act shall abridge or modify existing rights to Elwha River water.

(b) Nothing in this Act shall affect the rights of any Indian Tribe secured by Treaty or other law of the United States.

(c) This Act does not modify any of the Administrator's obligations or require the Administrator to take any actions regarding the protection, mitigation, or enhancement of fish and wildlife or expand those provided for under the Pacific Northwest Power Planning and Conservation Act, Public Law 96–501. Notwithstanding any other provision of law, the Administrator shall not be required to make any expenditures from the Bonneville Power Administration fund for the operation, maintenance, rehabilitation, improvement, or removal, breach, or bypass of the Projects.

SEC. 9. AUTHORIZATION OF APPROPRIATIONS.

Effective date.

There are authorized to be appropriated to the secretary of the interior for expenditure through the Assistant secretary for Fish, Wildlife, and Parks and to the secretary of Commerce for expenditure through the National Marine Fisheries Service such sums as may be necessary to carry out the purposes of this Act: *Provided*, That such authorization shall not become effective until sixty days following submission of the report provided for in section (3)(c) of this Act.

Approved October 24, 1992.

Appendix 2

Elwha River Fish Restoration Plan

Introduction

This plan provides a description, timeline, and cost estimate to achieve full restoration of Elwha River anadromous fisheries under the alternative of dam removal. The fish restoration plan builds on all available information generated over the past decade, including new information developed since completion of *The Elwha Report* (USDI et al. 1994). Fish restoration described in the plan begins prior to dam removal and continues for ten years thereafter to complete activities in fish stock assessment, hatchery brood development, reintroduction of anadromous fish by outplanting and other means, and interim and final evaluations of the effort.

The ten fish stocks that historically used the Elwha River basin prior to construction of the dams are addressed—winter and summer steelhead, searun cutthroat and char, spring and summer/fall chinook, coho, pink, chum, and sockeye salmon. In this plan, a fish stock is considered a discrete population that does not interbreed to any substantial degree with any other stock due to separation in space and/or time from other stocks (WDF et al. 1993). Also, this plan assumes:

- Anadromous fish would not be reintroduced in the upper Elwha River until safe downstream passage at the dam sites is ensured.
- The viability of lower river fish habitat and fish facilities may be significantly impaired by suspended sediment during and immediately following dam removal (one to two years).
- Juvenile outplanting is desirable to reintroduce most fish stocks in the upper basin because: (1) outplanting could markedly accelerate the reintroduction of anadromous fish to the upper river compared to natural recolonization, and 2) outplanting would permit, in certain cases, selective reintroduction of stocks that may be better suited to sustained natural production in the Elwha River than those which presently exist in the lower river.

This plan presents more than one option for restoring some fish stocks, improving the prospects for fully restoring anadromous fisheries in the shortest time. Anadromous fish released in previously inaccessible habitat may require varying amounts of time and variable levels of outplanting before full utilization of the habitat can be expected (FERC 1993).

Although not a primary option in all cases, reliance on natural recolonization is included where runs are now present in the lower Elwha River. Under this option, adult fish can be expected to penetrate the upper drainage and reestablish themselves over varying lengths of time once access is reestablished. This approach can be effective as demonstrated on the south fork of the Skykomish River where new habitat became available to adult salmon above Sunset Falls, and runs of chinook and pink salmon were largely established by allowing adults access to this new habitat (as opposed to intensive juvenile outplanting of these species) (Seiler 1991).

More than one option is presented for restoring most fish stocks, described in priority order. All will continue to be investigated, but those options that demonstrate most promise would be pursued based on priority shown. Recently developed information on stock status and availability has significantly reduced the 28 fish restoration options described in *The Elwha Report* to the 17 listed in table 1 and described below.

For certain fish stocks (searun cutthroat, searun char, and sockeye salmon), natural recolonization is the only restoration option presented. Searun cutthroat and char are expected to fully recover on their own. Difficulty in securing suitable brood sources is a consideration, as is lack of hatchery support facilities for these stocks in the Elwha River.

Restoration Options

Principal restoration activities for all stocks (except searun cutthroat and char) fall into five general categories, for which timelines and costs follow.

Stock-status assessment. The most current information on stock status was used to determine the suitability and availability of Elwha stocks for restoration. Although use of native fish stocks should yield the greatest adult return (Reisenbichler 1988; Nickelson et al. 1986) and native stock is the first priority in restoration options (if available), past hatchery introductions and loss of upriver habitat have significantly reduced or eliminated a number of native Elwha fish stocks. Efforts have been underway for several years to identify and develop native Elwha stocks, or locate the most suitable substitutes.

Broodstock development, maintenance, and protection. Hatchery support is necessary to develop and maintain broodstock for juvenile outplanting. The two fish facilities in the lower river (Washington Department of Fish and Wildlife's rearing channel and the Lower Elwha Klallam Tribe's hatchery) would be modified to produce juvenile fish for outplanting. During periods of poor water quality during and immediately after dam removal, the Department of Fish and Wildlife Soleduc Hatchery on the Washington coast would serve as a temporary brood refuge for chinook salmon, and the tribe's hatchery would serve as a temporary brood refuge for other stocks (steelhead, coho, and chum salmon) as noted below.

Insofar as feasible, within-basin hatchery facilities would be used to develop and maintain brood to reduce logistical costs in fish transfer and avoid fish-transfer restrictions due to fish disease concerns. Facility modifications would include improvements to water supply and upgrades in incubation and support capability. Modifications would incorporate innovative hatchery practices (such as sub-surface feeders, cover, and rugose incubation substrate) that simulate natural rearing conditions and potentially improve survival in the wild (Wunderlich and Pantaleo 1995).

Fish collections for brood development would rely on traditional netting and/or hook-and-line sampling. A reconnaissance engineering survey (Rainey 1993) indicated little potential for temporary weirs or similar devices for collecting salmon and steelhead brood in the lower Elwha River.

Outplanting. Outplanting would be done for at least ten years to allow for uncertainties in stock availability and reintroduction methods. Outplants would be at levels consistent with carrying capacity and expected redistribution of outplanted fish. Carrying capacity estimates are based on Hosey and Associates (1988) habitat surveys (figure 1). Stocks with potentially long rearing between outplanting and emigration would be seeded in the low range of their expected carrying capacity, while smolts would be seeded at or somewhat above carrying capacity.

This plan emphasizes juvenile outplanting at very early life stages (including eyed egg and swim-up fry) to reduce hatchery exposure and increase natural selection—factors believed advantageous to sustained survival in the wild. However, other outplant strategies (in terms of time, size, and location) may be pursued, given the uncertainties involved in restoring anadromous salmonids (Fedorenko and Shepherd 1986; Winton and Hilborn 1994). Time and life history stage (egg development or fish size) of hatchery outplants would mimic that of wild cohorts to reduce competition/predation and optimize survival. Table 2 summarizes pertinent life history information on stocks intended for outplanting in the upper Elwha River basin.

For outplanting purposes, the river basin was divided into reaches believed most suitable for reintroduction of each stock. Carlson Canyon Falls (river mile 34) was considered the division between spring and summer/fall chinook habitat and between summer and winter steelhead habitat; the Rica Canyon entrance (river mile 16) was considered the upper limit of pink and chum salmon habitat (figure 1). No outplanting would be done above reported natural barriers (Hosey and Associates 1988).

Outplanting method would vary by location. Above river mile 16, outplanting of all stocks would be done by helicopter airlift (Wunderlich et al. 1993) because of lack of road access. However, aerial flights in the park must be minimized because of the federally listed murrelet (spring-through-fall nesting and roosting) and the wilderness area. Below river mile 16, outplanting would be done by conventional tank truck.

Temporary conditioning, or acclimation, ponds would be employed where possible for chinook and steelhead outplants to increase survival and adult return to the vicinity of the ponds. Such ponds would include side channels fitted with temporary water control structures to allow short-term (up to two months) holding and rearing prior to initial emigration.

Harvest Management. Management of impacting fisheries is an integral part of fisheries restoration. Over the rebuilding period, harvest rates would be phased down on stocks presently supported by hatchery production (summer/fall chinook salmon, coho salmon, winter and summer steelhead) to a level conducive to wild production. Guidelines for achieving these harvest management goals are found in the Puget Sound Salmon Management Plan and the draft Salmon and Steelhead Management Plan for Strait of Juan de Fuca Terminal Areas.

Primary harvest management responsibilities are shared by the state of Washington, the tribe, and Olympic National Park. Specifically, the Lower Elwha Klallam Tribe has the primary responsibility for managing tribal fisheries in the Elwha River and other terminal areas in the Strait of Juan de Fuca. The Washington Department of Fish and Wildlife is responsible for the management of marine and freshwater (outside the park) nontribal salmon and steelhead fisheries, while Olympic National Park is responsible for managing nontribal fisheries within park boundaries. Although the state and tribe have primary harvest management responsibilities in marine waters, harvest management must be coordinated with the Pacific Fisheries Management Council and the Pacific Salmon Commission.

Evaluation. Evaluation is a necessary and integral component of the restoration plan. Evaluation components include selection of appropriate brood sources where more than one potential source exists, refinement of the restoration plan as more information on existing stock status becomes available, and determination of the effectiveness of reintroduction measures as indicated by adult returns or, in some cases, smolt output and survival.

A summary of restoration options for all stocks appears in table 1, and a detailed description of each restoration option follows. A timeline of major restoration activities appears in table 3; an outplanting schedule for all stocks appears in table 4.

For reference, a brief summary of current Elwha stock status precedes each stock's restoration options. Additional information on Elwha fish stock status is available in WDF et al. (1993) and FERC (1993).

Winter Steelhead

Elwha Stock Status

The early portion of the winter run steelhead (December through March) is largely based on Lower Elwha Klallam Tribal Hatchery production of nonnative stock, while the late portion of the run (mid-February through June) is considered a mixed1 , wild2 stock which is depressed3 because of habitat loss associated with the Elwha dams (WDF et al. 1993).

Escapement of late-run winter steelhead is unknown (WDF et al. 1993). Over the past three years, the Elwha Klallam Tribal Fisheries Department has taken nonlethal electrophoretic samples (Robbins et al. 1988) from a portion of the late winter steelhead run. When analyzed later this year, these samples should provide important information on the genetic make-up of the Elwha late winter run steelhead.

Option 1: Rely on upper-river rainbow trout population to naturally re-establish a native run.

This option relies on the existing rainbow trout population in the upper river to naturally reestablish a searun population after dam removal. Genetic work conducted by Reisenbichler and Phelps (1989) first revealed that these upper-basin trout may be descendants of Elwha steelhead, trapped in the upper river when Elwha Dam closed. Likewise, incidental capture of steelhead smolts at Elwha Dam's turbine screen suggested the upper river harbored a remnant steelhead population (Stone and Webster Engineering Corporation 1991). Headwater rainbow populations above constructed barriers in the mid-Columbia River are also believed to produce steelhead smolts (Mullan et al. 1992).

In 1994, an evaluation of the source and magnitude of steelhead smolt output from the upper Elwha River was attempted (Hiss and Wunderlich 1994a). A fish trap was installed at river mile 11, below Glines Canyon Dam, to enumerate and sample steelhead smolts. Resident adult rainbow trout were also collected in several mid-river tributaries to assess their genetic (electrophoretic) similarity to nearby steelhead stocks. Results suggested that only a small number of steelhead smolts (< 1,000) emigrated from the upper watershed, but they were indeed physiologically ready for marine existence.

Preliminary genetic analysis of mid-river adult rainbow trout samples (S. Phelps, WDFW, personal communication) suggested that historical hatchery rainbow trout releases in the upper basin had only limited success at reproducing in the wild. Moreover, collections from one site, the Little River (figure 1), suggested no evidence of hatchery rainbow trout origin, and that this subpopulation was similar to Olympic Peninsula steelhead.

Taken together, these results imply that the existing upper river rainbow trout could reestablish steelhead runs in the Elwha River. Given the small number of smolts produced, however, recovery could be a long process. Since pilot tests to culture the offspring of feral rainbow trout from the upper basin have not been successful (J. Meyer, Olympic National Park, personal communication), enhancement is not recommended at this time.

Option 2: Enhance late-run, lower-river stock.

This option, pursued concurrently with option 1, involves enhancement of the existing late-run stock in the lower river (if suitable) followed by outplanting after dam removal. This late-run stock is known to be primarily of wild origin (WDF et al. 1993; Winter 1989; Wunderlich and Hager 1993). If electrophoretic sampling by the Lower Elwha Klallam Tribal Fisheries Department suggests these fish are native Elwha stock, enhancement followed by outplanting would be pursued. Swim-up fry would also be outplanted in side channel habitat at two mid-river sites (Goldie and Hayes Rivers, figure 1) during spring/early summer, up to two years before dam removal. Direct eyed egg plants may also be done in suitable stream gravels of stable upriver tributaries during spring (table 2). Presmolts (9/lb) would be outplanted at two mid-river acclimation sites (Little River and Lake Sutherland), where fish would be held and fed for up to two months prior to volitional emigration.

As an added measure to conserve the remaining lower-river wild stock during evaluation and brood development, winter run hatchery releases from the tribal hatchery would be marked (adipose-clipped) beginning in 1996 (D. Morrill, Elwha Tribe Fisheries Department, personal communication). Management could then institute catch-and-release for wild stock in the lower river steelhead fishery.

Option 3: Rely on natural recolonization by lower-river stock.

Natural recolonization of the upper river is expected to occur over an uncertain time period once access to the upper river is reestablished. Because of the strong nonnative influence in the early returning portion of the run due to the hatchery program, this option is considered least desirable.

Summer Steelhead

Elwha Stock Status

Summer run steelhead are considered depressed due to loss of habitat associated with the Elwha dams, and escapement is unknown (WDF et al. 1993). The Washington Department of Fish and Wildlife currently releases nonnative summer steelhead (Skamania stock) in the lower river from the Bogachiel Rearing Ponds (Johnson, WDFW, personal communication).

Option 1: Rely on the upper-river rainbow trout population to re-establish native run.

This option is the same as option 1 for winter steelhead. As noted above, it is possible that a component of the landlocked rainbow trout population in the upper watershed would display summer return timing. That reach of the upper Elwha River above river mile 34 (Carlson Canyon Falls) would be reserved for steelhead reestablishment under this and following options.

Option 2: Rely on natural recolonization by lower-river stock.

Natural recolonization of the upper river is expected to occur over an uncertain time period once access to the upper river is reestablished. In the absence of other measures to introduce summer steelhead in the uppermost reaches of the river basin, the lower river stock would gradually penetrate the watershed, but the recolonization period could be lengthy given the depressed status of the stock. To reduce nonnative hatchery influence in the lower-river stock prior to dam removal, Washington Department of Fish and Wildlife hatchery releases from the Bogachiel Rearing Ponds would be discontinued.

Option 3: Enhance native component of lower-river stock.

This option involves enhancement of any remaining native component of the lower Elwha River stock followed by outplanting in the upper watershed (above river mile 34). However, the depressed status of this stock, coupled with a history of nonnative hatchery releases in the lower river, suggest that few natives are left.

Searun Cutthroat and Native Char

Elwha Stock Status

Status of searun cutthroat and native char in the lower river is unknown, but these populations are likely negatively affected by loss of access to the upper river and habitat degradation in the lower river due to the Elwha dams. Searun cutthroat in the lower river may be limited by lack of small tributaries for spawning and rearing due to the Elwha dams (FERC 1993). There has been no past enhancement of searun cutthroat in the Elwha River, and no brood sources are available in the Elwha River vicinity (Freymond, WDFW, personal communication).

Option 1: Rely on natural recolonization.

Natural recolonization of the upper river is expected over an uncertain time period once access to the upper river is reestablished. Remnant, landlocked forms of both species may exist in the upper watershed in an analogous manner to rainbow/steelhead, noted above. These resident populations may contribute to reestablishment of native anadromous populations after removal of the Elwha dams.

Spring Chinook Salmon

Elwha Stock Status

Spring chinook, if present, are undoubtedly very limited. Loss of access to upriver habitat due to the Elwha dams, coupled with possible co-temporal spawning with other chinook in the lower river, have reduced their numbers and perhaps their genetic distinction from later-timed chinook. Nonnative hatchery releases of Soleduc and Dungeness spring chinook were also made in the lower Elwha River in 1973 and 1977, respectively (FERC 1993).

Over the past several years, gillnet sampling has shown that very few chinook enter the Elwha River before early June (D. Morrill, Lower Elwha Klallam Tribal Fisheries Department, personal communication; Wunderlich and Hager 1993). Enhancing this portion of the run using native stock is therefore unlikely.

Option 1: Outplant juvenile summer/fall Elwha stock and rely on natural processes to establish an early run.

This restoration strategy entails collecting eggs from the early portion of the run, then outplanting juveniles in the uppermost reaches of the basin. Outplanting juveniles should accelerate the process of introducing the stock within its assumed historic range (above river mile 34).

When exposed to the upper river's environment, the existing summer/fall stock can be expected to exhibit an earlier-timed component (spring type), although it may take some generations for this expression to manifest itself (E. Brannon, University of Idaho, personal communication). An earlier-timed component would respond in part to the upper river's cooler temperature regimen, requiring earlier return and spawn timing to complete the life cycle (Brannon and Hershberger 1983). Among Pacific salmon, chinook are known to adapt rapidly to new situations (Healey 1991); significant shifts in spawn timing have been reported in response to new environmental conditions (Kwain and Thomas 1984).

Pre-smolts (180/lb) would be aerially outplanted in early spring above river mile 34 at a relatively high density (25% over carrying capacity), with some downstream displacement expected. This outplanting strategy would have two significant benefits in restoring a natural run to the upper Elwha River:

- It would allow at least some imprinting to improve return to the upper river, yet minimize interference with natural emigration (alteration of natural emigration patterns can negatively affect marine migration and survival). Outplanting in early spring would be before any appreciable emigration pulse could be expected, based on previous Elwha emigration studies and data on smolt readiness (ATPase) for this stock (Wunderlich and Dilley 1990).

- It would mimic the expected time and size of natural outmigrants, which should improve survival and adult return (Reimers 1979). Time and size of outplanting would correspond closely to that previously observed among chinook emigrating from the upper Elwha River (Dilley and Wunderlich 1990).

Summer/Fall Chinook Salmon

Elwha Stock Status

Summer/fall chinook are a native stock of composite4 production associated with both the state and tribal fish facilities in the lower river. Stock status is healthy 5 (WDF et al. 1993).

Option 1: Outplant juvenile Elwha stock.

This restoration strategy involves collecting eggs across the range of the Elwha chinook spawn timing, then outplanting spring subyearlings to mid-river sites. Fingerlings (120-150/lb) would be outplanted to two mid-river acclimation sites (Little River and Lake Sutherland), held and fed for up to two months, then allowed to volitionally emigrate. Fingerlings would not be held at acclimation sites beyond June 30, however, since tag studies at the state fish facility suggest that rearing Elwha chinook past this date results in poor survival (P. Crain, Elwha Klallam Tribal Fisheries Department, personal communication). Additionally, fingerlings (90/lb) would be outplanted at a variety of mid-river sites during spring. Direct eyed egg plants may also be done in suitable stream gravels of stable upriver tributaries in early fall (table 2).

Given the healthy condition of this stock and the existence of hatchery production in the lower river, brood should be readily available. However, to safeguard the stock during the dam removal period, the state's Elwha facility production (450,000 yearlings and 2.2 million subyearlings) would be temporarily transferred to the their Soleduc Hatchery (north Washington coast) for up to three years, differentially marked to retain stock integrity, then returned in total to their Elwha facility.

Option 2: Rely on natural recolonization.

In the absence of other measures to introduce summer/fall chinook in the upper river basin, the lower river stock would gradually penetrate the watershed over an extended time period. However, during the Elwha dam removal period, the same measures to protect the Elwha stock (transfer to state Solduc Hatchery) would be necessary.

Coho Salmon

Elwha Stock Status

Coho salmon are a mixed stock of composite production associated with hatchery facilities in the lower Elwha River; status of the stock is healthy (WDF et al. 1993). Hatchery production began with Dungeness and Elwha parents at the state facility, but is now only at the tribal facility (FERC 1993).

Option 1: Outplant juvenile Elwha stock.

This option entails aerially outplanting Elwha subyearlings (swim-up fry) up to one year before complete dam removal. Outplanting would be at two mid-river sites (Elkhorn and Press Valley) at high densities (25% over carrying capacity). At these sites, fry would be hand distributed to ensure good dispersion. Scatter planting is preferable to mass planting of juvenile coho salmon, given their yearlong freshwater residency and strongly territorial behavior (Salo and Bayliff 1958). Direct eyed egg plants may also be made in suitable stream gravels of stable upriver tributaries in late fall (table 2).

Outplanting would be done only in mid-river sites above river mile 16 to reduce predation on juvenile pink and chum salmon outplants below this point (see succeeding sections on pink and chum salmon). On-station hatchery coho smolt releases would be delayed until June 1 to reduce predation on emigrating pink and chum salmon.

The existing Elwha coho salmon stock should be readily available for outplanting given its healthy status and the hatchery program; this stock is also the closest to native Elwha stock. During the dam removal period, the tribal hatchery would maintain its brood run of coho salmon and act to safeguard the stock.

Option 2: Rely on natural recolonization.

In the absence of other measures to introduce coho in the upper river basin, natural recolonization is expected to occur over an uncertain time period once access to the upper river is re-established.

Pink Salmon

Elwha Stock Status

Pink salmon are described as a native, wild stock whose status is critical based on chronically low escapements over the past decade (only four individuals were observed in extensive surveys in 1989 compared to counts of over a thousand in the early 1970s) (WDF et al. 1993). Most observers consider the stock extinct, and it has been petitioned for listing under the federal Endangered Species Act.

Chronically low escapements cast doubt on sufficient brood to establish a hatchery program. The existing lower river run is, in all probability, non-viable and probably consists only of Dungeness strays; the presence of an adequate genetic base to restore a run is also questionable (Jim Ames, WDFW, personal communication). Optimally, at least several hundred breeding individuals are desirable to avoid long-term problems of inbreeding and loss of genetic variability (Waples 1991).

Option 1: Import upper-river Dungeness stock.

The Dungeness River pink salmon run has several desirable traits as a donor stock for the Elwha. It is a native, wild stock (WDF et al. 1993) which has an "upper-river" component that returns early (late July) and spawns high in the system (spawning peaks at the end of August) (Lichatowich 1992). Upper-river spawning would encourage colonization throughout available habitat in the Elwha. Early return and upper-river spawning would minimize the risk of adversely affecting any remnant Elwha pink run, as historical spawner survey data for the Elwha indicate a September-to-October spawn timing (WDFW spawner survey data base), which is considerably later than upriver Dungeness stock. The Dungeness River is also geographically close to the Elwha and lies within the same fish health management zone, which would facilitate inter-basin transfer of fish or eggs.

The upper river Dungeness pink stock is a potential long-term prospect as a donor source for the Elwha. Unfortunately, this stock is presently considered depressed due to chronically low escapements (WDF et al. 1993), and is itself the subject of restoration planning (Lichatowich 1992). When the run rebounds, agreement on stock transfer would be needed between state and tribal management entities before export to Elwha, including concurrence on threshold levels of escapement before removal (B. Sele, Jamestown Tribe, personal communication). Comprehensive assessments of limiting factors have been made to reverse the Dungeness population's decline for future transfers to the Elwha (Hiss 1994, 1995a).

The outplant strategy shown in table 4 includes mass outplanting at densities within the possible carrying capacity of the lower river (below river mile 16, the assumed historical limit of pink salmon range). Mass outplanting is recommended to swamp predators that can significantly limit juvenile pink populations (Ames, WDFW, personal communication). Remote site incubators also may be employed to introduce juvenile pink salmon.

Since this option (and option 2 below) relies on importing fish, and the existing Elwha stock is considered by most observers to be nonviable, no measures to protect any remnant Elwha stock during dam removal are planned.

Option 2: Import Finch Creek Stock.

If option 1 fails, option 2 consists of importing pink salmon stock from the Washington Department of Fish and Wildlife Finch Creek Hatchery program in Hood Canal. The Finch Creek stock originated from the Dungeness in the 1950s, and it has been maintained without infusion of outside stocks since. This stock is now considered genetically distinct from the Dungeness based on electrophoretic analysis. Hatchery egg takes are relatively stable and approach 2 million (Ames, WDFW, personal communication).

A portion of the Finch Creek stock would be moved to the Elwha system for hatchery culture and outplanting. More stringent fish-health transfer restrictions could be required because of its geographic location.

Chum Salmon

Elwha Stock Status

Chum salmon are considered a native, wild stock (WDF et al. 1993). The tribal hatchery produced nonnative chum (principally Walcott Slough from Hood Canal), but the program was discontinued about 1980. Spawner surveys conducted over the past two seasons indicated population sizes of only approximately 150 in 1993-1994 (Wunderlich et al. 1994) and 300 in 1994-1995 (Hiss 1995b), compared to historical estimates in the many thousands of spawners. The early portion of the run appears to be native Elwha stock, based on available genetic (electrophoretic) information. The population is largely confined to side channels in the lower one mile of river. An emigration study of Elwha chum salmon this past spring (R. Peters, USFWS, personal communication) suggested that predation by hatchery coho releases in the lower river may be one important factor in the Elwha chum population's current decline.

Option 1: Enhance existing Elwha stock.

Considering the limited number of Elwha chum, plus lack of an Elwha hatchery brood run, a brood run would be established at the tribal hatchery prior to dam removal (table 3). Brood collection would focus on any identifiable native component as a first priority. Smolt outplants (450/lb) and egg outplants in remote site incubators would be done below river mile 16 (the presumed historical upper limit of chum salmon range) (Manuel et al. 1991).

Option 2: Rely on natural recolonization.

Once access is reestablished, natural recolonization of the lower river (below river mile 16) would occur over an uncertain time period. Since measures to protect the stock during the dam removal period would still be necessary, brood collection would be done also under this option.

Sockeye Salmon

Elwha Stock Status

The native lower river stock no longer exists because Elwha Dam blocks access to Lake Sutherland (figure 1), which is needed to complete the freshwater phase of the sockeye life cycle (FERC 1993).

Option 1: Rely on Lake Sutherland kokanee to reestablish a native sockeye run.

Kokanee (nonanadromous sockeye) may retain the genetic drive for anadromy over a number of generations; this phenomenon underpins the draft recovery plan for Snake River sockeye salmon in the Stanley Lakes Basin of Idaho (Bevan et al. 1992). Regaining unrestricted access to the sea by removal of screens in the Lake Sutherland outlet (after removal of Elwha Dam) may, in time, permit reestablishment of a native sockeye run from the existing kokanee population of Lake Sutherland. Indian Creek also would be surveyed to ensure that passage (adult and juvenile) is possible.

A key question is the uncertain parentage of Lake Sutherland kokanee. Washington State hatchery records indicate release of nonnative (Lake Whatcom stock) kokanee in Lake Sutherland from at least 1944 until 1964. The Lake Sutherland kokanee population has sustained itself to present, but the influence of nonnative kokanee releases on the native kokanee/sockeye population is uncertain.

To answer questions about Elwha sockeye restoration, an examination of the existing kokanee population was conducted in 1994 to determine the number and genetic makeup (by DNA testing) of Lake Sutherland kokanee, the lake's productive potential for sockeye, and whether smolt production presently occurs in the kokanee population (Hiss and Wunderlich 1994b). Results to date suggest that a historic sockeye population of at least several thousand beach spawners exist, but no evidence of anadromy (smolt production) in the lake's kokanee population was found. Information on genetic makeup of the kokanee population will be available later this year.

The presumptions of Elwha sockeye parentage and ability to stimulate anadromy may not be met, and prospects for successfully importing a nonnative stock are not optimistic. Reliance on natural reestablishment of sockeye is, therefore, the only proposal.

Costs

Costs to support the fish restoration plan total $6.7 million. These consist of hatchery production and program management costs (table 3), plus capital improvements in the Elwha Klallam Tribal and Washington Department of Fish and Wildlife fish facilities (able 5). In total, these funds cover fish stock assessment, brood development and maintenance, outplanting, and project evaluation and management over the entire period of fish restoration. Hatchery support and outplanting costs assume maximum fish production under any option at target outplanting levels (table 4).

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Table 1. Summary of Options for Restoring Elwha River Anadromous Fish.

Option	Description
	Winter Steelhead
1	Rely on upper-river rainbow trout population to re-establish native run.
2	Enhance late-run, lower-river stock.
3	Rely on natural recolonization by lower-river stock.
	Summer steelhead
1	Rely on the upper-river rainbow trout population to re-establish native run.
2	Rely on natural recolonization by lower river stock.
3	Enhance native component of lower-river stock.
	Searun Cutthroat and Native Char
1	Rely on natural recolonization.
	Spring Chinook Salmon
1	Outplant juvenile summer/fall Elwha stock and rely on natural processes to establish an early run.
	Summer/Fall Chinook Salmon
1	Outplant juvenile Elwha stock.
2	Rely on natural recolonization.
	Coho Salmon
1	Outplant juvenile Elwha stock.
2	Rely on natural recolonization.
	Pink Salmon
1	Import upper-river Dungeness stock.
2	Import Finch Creek stock.
	Chum Salmon
1	Enhance existing Elwha stock.
2	Rely on natural recolonization.
	Sockeye Salmon
1	Rely on Lake Sutherland kokanee to re-establish a native sockeye run.

Table 2. Spawning, incubation, and emigration data on stocks targetted for outplanting. Data based on lower Elwha stocks, except for pink salmon (which is upper Dungeness River stock).

Stock	Spawning range	Spawning peak	Eyed egg peak [A]	Emergence peak [A]	Emigration range
Steelhead (late winter)	Early Mar - late May	Late Apr	Late May	Early Jul	Mid Apr - mid Jun
Chinook	Late Aug - early Nov	Mid Sep	Mid Oct	Late Mar	Variable (year round with late spring and late summer peaks) [B]
Coho	Late Oct - mid Jan [A]	Late Nov	Early Mar	Late May	Mid Apr - mid Jun
Pink	Late Jul - mid Sep	Late Aug	-	-	Early Apr - late May [C]
Chum	Mid Nov - early Jan	Mid Dec	-	-	Mid Mar - mid Jun [D]

[A] Based on hatchery temperature units for each stock and river thermograph data (L. Ward and D. Morrill, LET Fisheries Department, personal communications).

[B] Dilley and Wunderlich (1990).

[C] Hiss (1994).

[D] Based on 1995 Elwha chum salmon emigration study (R. Peters, USFWS, personal communication).

Table 3. Major fish re-introduction activities and associated costs.

Year[a]	Major Activities						Costs ($K)		
	Winter sthd	Chinook	Coho	Pink	Chum	Sockeye	Hatchery support[b]	Field support[c]	Total
n-2	Collect brood & pilot rear			Assist w/Dungeness recovery			0	78	78
n-1	Collect brood; outplant fry	Transfer eggs out-of-basin	Maintain brood; outplant eggs/fry	⇓	Collect brood; outplant eggs/fry		68	97	165
n	Collect brood; outplant fry	Collect brood, (maximum removal) & transfer eggs; outplant	⇓	⇓	⇓	Assess passage	84	103	187
n+1	Collect brood; outplant fry and pre-smolts	⇓	⇓	⇓	Continue (but with maximum brood removal)	Improve passage as needed	84	103	187
n+2	Maintain brood; outplant; survey returns	Restore Elwha brood run; outplant	⇓	Outplant Dungeness stock	Continue	Remove screens from lake outlet	85	113	199
n+3	⇓	⇓	Continue & survey returns		Continue & survey returns		84	113	197

Year[A]	Major Activities						Costs ($K)		
	Winter sthd	Chinook	Coho	Pink	Chum	Sockeye	Hatchery support[B]	Field support[C]	Total
n+4	⇓	Outplant & survey returns	⇓	Outplant & survey returns	⇓		85	113	199
n+5	⇓	⇓	⇓	⇓	⇓	Survey	84	113	197
n+6	⇓	⇓	⇓	⇓	⇓	⇓	85	113	199
n+7	⇓	⇓	⇓	⇓	⇓	⇓	84	113	197
n+8	⇓	⇓	⇓	⇓	⇓	⇓	85	113	199
n+9	⇓	⇓		⇓	⇓	⇓	81	110	191
n+10		⇓		⇓		⇓	17	95	112
						Total:	928	1379	2306

[A] Year n is dam removal.

[B] Hatchery production costs at $3.50/lb of fish produced.

[C] Evaluation (survey) and outplanting costs. Evaluation costs consist of project personnel (1 full-time biologist at $35,000/yr and 3 half-time biologists at $25,000/yr); equipment O&M at 10% of capital costs (Table 3) annually; and helicopter service during survey years (20 hr/yr at $535/hr). Outplanting costs at $3.65/lb by air and $0.65/lb for ground transport.

Table 4. Outplant schedule.

Stock	Outplant location	Outplant method	Target outplant season	Target outplant number	Target outplant size	Hatchery
Winter steelhead	Goldie and Hayes Rivers	Air	Spring/ early summer	1728000	Swim-up fry (1,800/lb)	LET
Winter steelhead	Mid-river acclimation sites (Little R. and L. Sutherland)	Ground	Early spring	145000	Pre-smolts (9/lb)	
Chinook (early)	RM 34-42	Air	Early spring	172800	Fry (180/lb)	LET/WDFW Elwha and Soleduc
Chinook	Mid-river acclimation sites (Little R. and L. Sutherland)	Ground	Spring	200000	Fry (120-150/lb)	LET/WDFW Elwha and Soleduc
Chinook	RM 5-16	Ground	Spring	180000	Fingerling (90/lb)	
Coho	Mid-river side channels (Elkhorn and Press Valley)	Air	Spring	1152000	Swim-up fry (1,200/lb)	LET
Pink (Dungeness)	RM 5-16	Ground	Spring	315000	Smolt (1,125/lb) and eggs	WDFW Dungeness

Stock	Outplant location	Outplant method	Target outplant season	Target outplant number	Target outplant size	Hatchery
Chum	RM 5-16	Ground; RSIs	Spring	650000	Smolt (450/lb) and eggs	LET

Table 5. Hatchery-related capital costs.

Item	Cost ($K)	
Tribal Fish-Production Facility		
-Increase water supply	250	
-Upgrade incubation facilities	380	
-Upgrade brood holding and rearing	1040	
-Upgrade support facilities	470	
-Administration, contingency, engineering	991	
Sub-total:		3131
WDFW Fish-Production Facilities		
-Build additional incubation facilities at Soleduc Hatchery	137	
-Move fish to Soleduc Hatchery and mark them	589	
-Move fish and incubation facilities back to Elwha, administer program	228	
Sub-total:		954
Outplanting and Evaluation Equipment		
Boat	10	
Truck	25	
Distribution tank	3	
Miscellaneous	20	
Sub-total:		58
Total:		4363

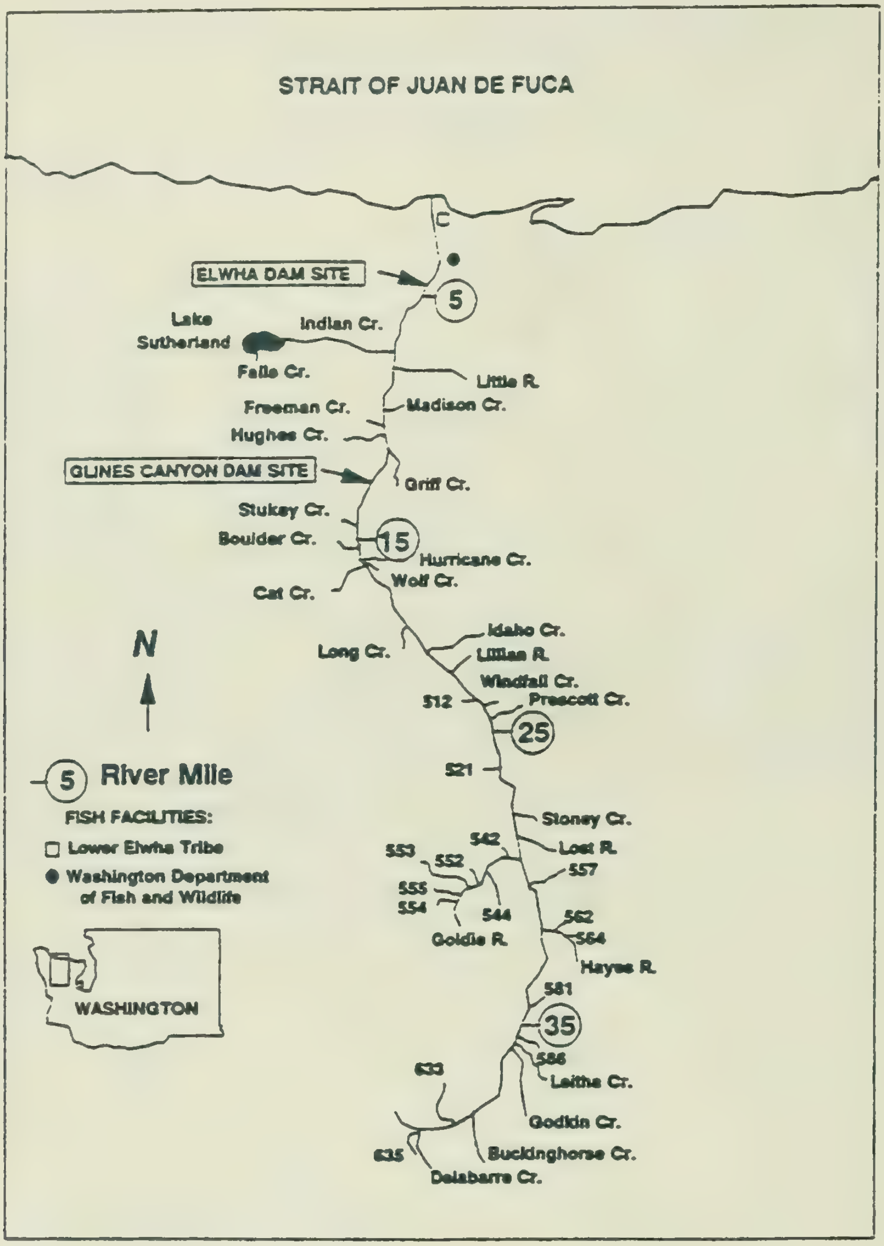

Figure 1. Lineal extent of anadromous fish habitat in the Elwha basin.

Appendix 3

Revegetation Plan

Glines Canyon Project Area

Restoration Objectives

Restoration of the Elwha River ecosystem and disturbed habitat of the Glines Canyon Project involves several issues and concerns. The National Park Service (NPS) is mandated to conserve and protect native species of plants and animals and perpetuate natural processes. Resources unique to Olympic National Park, or those that are limited in their extent on the Olympic Peninsula due to human-induced changes (such as old-growth forest), are of particular concern. While anadromous fish restoration is a primary objective of the overall dam removal proposal, the NPS must adopt a landscape- or ecosystem-level approach in developing restoration objectives, plans, design standards, and actual methodologies. Over time, the restored area would attain characteristics of the surrounding area now managed as wilderness and could eventually be proposed for inclusion in wilderness. The restoration process must be carefully designed to meet the objectives of full ecosystem restoration and perpetuation of natural processes and should not preclude the opportunity for eventual wilderness designation. Primary NPS restoration objectives are:

1. Restore the ecosystem to a close approximation of the conditions and processes found prior to dam construction, and achieve structurally complex vegetative communities as quickly as reasonably achievable.

2. Allow erosive processes to naturally form surface contours and topographic features within the reservoir area.

3. Allow the river to reestablish the river channel in a manner to maximize natural hydrological features including variable channel width and depth, geometry, sinuosity, and proportion of pools and riffles, while permitting the river to regain dynamic equilibrium within the floodplain.

4. Restore sediment and water flow regimes (daily and seasonal variations in flow), and sediment loading, that mimic natural annual and long term patterns caused by flood and drought.

5. Replant native riparian and upland vegetation within the reservoir area and along approximately three miles of restored powerline corridors. Revegetate the area to provide for erosion control while replicating representative community types, species composition, plant density, spacing, and overall structure. Terraced side slopes may be allowed to stabilize prior to planting. The active river channel would be allowed to revegetate naturally by wind and waterborne seed and natural rooting of woody debris (branches, limbs, etc). Minimize invasion by nonnative invasive plant species.

6. Promote the natural development of aquatic habitat within the restored river channel to both enhance fish restoration efforts by providing rearing habitat and resting areas, and to assist prompt recolonization by invertebrate fauna.

7. Protect designated wildlife and plant species, and their critical habitats, during dam removal and construction activities.

8. Permit the area, over time, to be subjected to natural processes, disturbances, and environmental perturbations such as floods, windstorms, natural (lightning) fires, native forest insects and disease, and other similar processes.

9. Thoroughly document and systematically monitor the restoration to permit future evaluation of the strategies and techniques used. Documentation would include a comprehensive project history.

10. Encourage independent research of this restoration project and facilitate communication of information and findings with other agencies and institutions.

RESTORATION SCHEDULE

2-3 Years Prior to Dam Removal

* Conduct empirical growing trials to identify candidate revegetation species and their performance in lake silts.

* Initiate seed and cone collection; sort and clean.

* Determine most cost-effective propagation methods for selected plant materials.

* Continue compilation of restoration bibliography.

* Control and remove upstream nonnative invasive plants.

Upon Approval of Restoration Funding

* Continue aggresive control program of nonnative invasive plants.

* Begin large scale plant material production.

* Initiate contracting with non-NPS propagation sources (Natural Resources Conservation Service Plant Material centers, U.S. Forest Service, commercial growers).

* Begin formal documentation of restoration sequence.

Optional - Depending on level of funding:

* Convert sites at Sweet's Field and/or Elwha Ranger Station for plant propagation and materials storage.

* Install seed traps within Elwha drainage to provide passive seed collection and assess potential for establishment of nonnative invasive species.

During Initial Dam Removal/Sediment Stabilization Phase

* Relocate coarse woody debris, as needed, to promote the recolonization of native species, and to achieve a more natural distribution within the former lakebed.

* Follow reservoir dewatering with initial seeding and planting.

* Use helicopters to overseed inaccessible areas.

Optional - Depending on level of funding:

* Treat selected sensitive or unstable areas with biotechnical slope stabilization techniques.

1 to 3 Years Following Dam Removal

* Intensively plant selected revegetation species within each habitat type.

* Continue monitoring and control of nonnative invasive plants.

* Monitor revegetation.

Year 4, and Continuing

* Implement remedial measures as necessary.

* Restore construction and staging areas.

* Monitor and document recovery.

COSTS

Glines Canyon Project Habitat Restoration (1995 dollars).

	Part of Alternative	Recommended*
Prior to Dam Removal		
Information gathering/research		25,000
Growing trials (in progress)	—	
Seed and cone collection, processing		80,000
Research propagation methods, contracting		12,000
Restoration bibliography	5,000	
Upon Approval of Restoration Plan and Funding		
Control nonnative invasive plants	40,000	
Plant materials production		200,000
Convert NPS sites for propagation activities		170,000
Contracting for plant materials propagation	450,000	
Install seed traps		8,000
Initial Dam Removal Phase		
Transport/placement large woody debris	25,000	50,000
Initial revegetation (seeding/planting)	350,000	
Helicopter overseeding	60,000	
Biotechnical slope stabilization		50,000
1 to 3 Years Following Dam Removal		
Plant trees and other native vegetation	200,000	
Control nonnative invasive plants	30,000	
Monitor revegetation	20,000	
Year 4, and Continuing		
Follow-up revegetation in failure areas	50,000	
Monitoring/documentation (vegetation only)	10,000	
Subtotal	1,315,000	520,000
Contingency (20%)	263,000	104,000
TOTAL	1,578,000	624,000

* Dependent on level of funding

Elwha Project Area

Restoration Objectives

The primary objective for the Elwha Project lands and facility area is to restore and protect the ecosystem, including the anadromous fish runs that were affected by the construction of the Elwha Project. To achieve this objective, the plan would include measures to restore the biological, hydrologic and physical processes that occurred prior to the construction of the dam.

The Elwha Project lands and facilities total about 1000 acres and include about 265 acres presently covered by Lake Aldwell, 675 acres of second growth forest land bordering the reservoir, 70 acres of riparian bottomlands located where the Elwha River and Indian Creek enter Lake Aldwell, and about 40 acres that have been developed or altered for roads, parking, and project facilities.

Upon acquisition of the Elwha project lands the secretary of the interior would determine the specific management plan for these lands as required under Section 3(c)(3) of P.L. 102-495. Currently there are no revegetation plans for the second growth forest lands or riparian bottom lands. Limited work would be conducted on the 40 acres that have previously been developed or altered.

The following guidelines would be used to direct the habitat restoration efforts for the Lake Aldwell lakebed.

1. Restore the biological, hydrologic, and physical processes while taking into account water supply and flood control objectives.

2. Restore the Lake Aldwell area to pre-dam conditions and attributes.

3. Allow for the re-establishment of river channel dynamics, including meander and pool-run-riffle composition.

4. Allow for the restoration of anadromous fish spawning, rearing and holding habitat.

5. Use native or sterile non-persistent plant species in the reseeding or revegetation program.

6. Control or eliminate nonnative invasive species as necessary.

In addition, a monitoring program should be included in the restoration plan to evaluate and document the effectiveness of the management prescriptions and to serve as the basis for implementing corrective measures.

1. Lake Aldwell Lakebed. The focus of the habitat restoration plan for the Elwha Project lands would be on the Lake Aldwell lakebed because of the major changes that have occurred from being flooded for 80 years. The natural erosion sediment management alternative would result in a remixing and redistribution of a portion of the accumulated sediments. As a result of drawdown, a series of terraces similar to historic terraces in upstream flats would form. The quantity and width of terraces would be dependent upon a number of factors occurring during drawdown including stream flow, channel meander patterns, etc.

The riparian bottomlands at the confluence of Indian Creek and the Elwha River are composed of mixed coniferous/deciduous forests, coniferous forests, palustrine forests, emergent wetlands. The emphasis for this area would be to preserve the diversity and the value of the existing habitats. The Indian Creek channel would be allowed to reestablish itself during controlled drawdown and should result, over time, in a meandering channel with numerous pools, runs, and riffles.

2. The Elwha River Channel Outside the Reservoir Zone. Within the project boundary, the Elwha River channel and adjacent riparian lands, located both upstream from Lake Aldwell (about 2000 feet along one bank) and downstream from Elwha Dam (about 2000 feet along both banks), are relatively undisturbed so would require a minimal level of restoration effort. Habitat restoration measures would probably be limited to the removal and revegetation of the transmission line access road following the removal of the transmission lines and poles. It is anticipated that the future management of these project lands would be to preserve these areas in their natural state.

3. Forest Lands Bordering Lake Aldwell. The area bordering Lake Aldwell consists primarily of second growth forest and includes a combination of coniferous, deciduous, and mixed forests. Much of this land is steep and is prone to erosion and landslides, if the vegetation is removed. Because of the potential of this area to seriously impact down slope habitats including the Elwha River, a preservation/conservation management objective is recommended. No habitat restoration measures are proposed. Not all of the forest land is on steep slopes and would be available for such purposes as described in Section 3(c)(3) of P.L. 102-495.

4. Disturbed Project Lands. About 40 acres of land have been disturbed as a result of facility construction (dams, powerhouses, penstocks, access roads, parking, transmission corridor, and support facilities) and other developments, such as the Elwha Resort and a former gravel pit. While the disturbed areas could be improved for wildlife, it is expected that some of these lands would be maintained in their present condition or developed for other purposes. Possible options include the location of public education and interpretation facilities either jointly or separately by the U.S. Fish and Wildlife Service, the National Park Service and the Lower Elwha S'Klallam Tribe; public access to the area; and development by the Tribe for cultural purposes and economic and residential development. The need for habitat restoration measures would depend largely on what development or land use decisions are made. Specific habitat restoration measures would be developed, as needed, but are assumed to be limited.

Restoration Schedule

It has been assumed that the habitat restoration schedule for the Elwha Project would be similar to the schedule described for the Glines Canyon Project (see above). These schedules would be further refined during the environmental impact statement / advanced planning process to reflect the dam removal and sediment stabilization timetable.

COSTS

Elwha Project Habitat Restoration (1995 dollars).

	Part of Alternative	Recommended*
Prior to Dam Removal		
Seed and cone collection, processing	45,000	
Upon Approval of Restoration Plan and Funding		
Control nonnative invasive plants	25,000	
Plant material production		100,000
Develop Elwha Project or tribal lands for propagation use	100,000	
Contracting for plant materials propagation	240,000	
Install seed traps		5,000
Initial Dam Removal Phase		
Transport/placement of large woody debris	10,000	15,000
Seeding and planting	200,000	
Helicopter overseeding	30,000	
Biotechnical slope stabilization		50,000
1 to 3 Years Following Dam Removal		
Plant trees and other native vegetation	125,000	
Control nonnative invasive plants	20,000	
Monitor revegetation	20,000	
Year 4, and Continuing		
Follow-up revegetation in failure areas	25,000	
Monitoring/documentation (vegetation only)	10,000	
Subtotal	750,000	270,000
Contingency (20%)	150,000	54,000
TOTAL	**900,000**	**324,000**
Grand Totals for Glines Canyon and Elwha Habitat Restoration	**$2,478,000**	**$948,000**

* Dependent on level of funding

Anticipated Revegetation Measures

Sediment Constraints

Natural erosion of sediments is the proposed action. Under this alternative it is anticipated that approximately 60 percent of the silt and clay, and 25 percent of the sand and larger-sized sediments would be transported downstream. The sediments remaining in the lakebeds should largely consist of a mix, though there may be some areas that are not well worked by the river during drawdown and form areas primarily composed of fines or coarse sediments. During the staged drawdown, the river would not meander from canyon wall to canyon wall. Benches or terraces would be left where the river does not rework the sediments, as well as where they occurred historically. The number and depth of terraces that form would be dependent upon a number of variables, therefore the revegetation plan would need to focus on adaptive management. The terraces should not be prone to erosion, as shown in the 1994 drawdown test, except where the river channel abuts a terrace slope. The majority of terraces should be sandy with some silt, clay, gravel, cobbles and organic material. The terraces should provide a variety of planting options, including natural recolonization, seeding with different mixtures, and planting stock of different ages and intensity levels to accommodate a variety of conditions.

Plant Collection/Propagation

The collection of seeds, cones and cuttings would all occur within the Elwha drainage. If it is necessary to use non-indigenous material, only sterile, non-persistent species would be used, e.g., sterile wheat or oats.

Limited space at Sweets Meadow, limited time and funding to grow plant materials, and the availability of seed and plant stock would all influence the level of effort and final composition of the revegetation work. Modification of facilities at Sweets Meadow would depend on the level of funding received. A minimum two-year period is recommended for seed collection since conifers and many other natives do not produce good seed crops every year. In the park, one restoration objective is to achieve structurally complex communities as quickly as reasonably achievable, therefore it would be desirable to have a minimum of 3 years to grow larger plant materials.

Seeding

Aerial application of seed mixes is preferred over land or water based operations due to the more natural dispersal characteristics. Hydroseeding is not recommended due to the presence of additives (dye, tackifiers and filler) and the potential to cause rilling. However, in areas where hydroseeding might be economically or technically more feasible, a mixture without dye and tackifier may be applied. Mycorrhizal innoculants may be added to the seed mixtures depending upon results from 1995 growing trials.

Fertilization

Fertilization would be limited in application and would consist of random applications to individual plants to encourage dominance and diversity. Limited application would reduce the potential competition from broadcast fertilization of nonnative invasive species. High nitrogen levels have been shown to alter the progression of natural succession by favoring fast-growing, heavy feeding invasives. Broadcast fertilization is also not recommended due to water quality concerns. Mycorrhizal innoculants may be utilized in place of fertilizers depending upon the results from growing trials.

The natural erosion alternative should result in a mixing of existing sediments, in most instances providing an adequate planting medium. The porosity of the reworked sediments should result in limited sheet flow and limited erosion. Some areas may not be reworked by the river during drawdown and would consist of primarily silts and clay or predominately coarse materials. An adaptive management approach would be necessary in these areas. One option in these areas would be the addition of excelsior materials as a soil amendment. Another option would be allowing pioneer plants adapted to those conditions to establish and begin the process of fixing nitrogen and other nutrients before the latter successional plant species would grow.

Control of Nonnative Invasive Species

The control and removal of upstream nonnative invasive plants would occur two to three years prior to dam removal to reduce the seed source. A list of exotic/adventive plants found in the Elwha valley is presented in table H-2 of the *1994 Elwha Report, Appendix H.* Species rated as either a significant or serious threat (based on the Exotic Plant Rating System developed by Olympic National Park) include:

Ilex aquifolium	English holly
Cytisus scoparius	Scot's broom
Cerastium fontanum spp. *triviale*	Common chickweed
Cirsium arvense var. *horridum*	Canada thistle
Hypericum perforatum	Common St. John's-wort
Lathyrus sylvestris	Small everlasting peavine
Leucanthemum vulgare	Ox-eye-daisy
Polygonum sachalinense	Giant knotweed
Senecio jacobaea	Tansy ragwort
Taraxacum officinale	Common dandelion
Agropyron repens	Quackgrass
Dactylis glomerata	Orchardgrass
Phalaris arundinacea	Reed canarygrass
Poa spp.	Bluegrass

Eleven additional species were rated as a potential threat and several species which may pose a threat were not rated.

In the first few years following revegetation of the lakebeds, intensive control and monitoring of invasives would occur. Control methods would include continuing reduction of the upstream and upwind seed sources, removal of invasives where they are inhibiting natural succession, and planting larger stock or competitive native species to shade out invasives. Rapid colonization by alder may provide the competition and shade necessary to reduce the spread of invasives. Alder stands can then be managed to promote succession.

Natural Recolonization

Natural recolonization would be utilized wherever it is consistent with the goals and objectives of the project. This would be the revegetation measure employed within the active stream channel. The river would continue to migrate and any plantings in this area would be severely jeopardized by channel movement. Upstream and windborne seeds, as well as rooting by floating stems of various species, such as willow and cottonwood, should provide sufficient sources for establishment of a colonizing riparian community. Additional seeding may be conducted in these area to assist with channel stabilization. Other areas that would be allowed to revegetate naturally could include rock outcrops, steep terrace slopes, and other areas for scientific study.

Lake Mills

Planting efforts within the Lake Mills lakebed would include intensive efforts near the river to establish riparian vegetation and shorten succession. Efforts would likely include thinning of colonizing alder stands and planting of conifers. Plant stock of various ages would be used to promote dominance.

Lake Aldwell

Planting efforts within the Lake Aldwell lakebed could be allowed to proceed with less intervention due to less restrictive goals than those necessary with Olympic National Park. Revegetation would focus more on natural recolonization and utilizing adaptive management methods to apply what has been learned at Lake Mills.

Plant Species Recommended for Collection

Plant species that are proposed for collection for use in revegetating the reservoirs are listed below. The categories reflect the quantity that would be collected, i.e., primary being the greatest effort and tertiary the least effort. A list of plant species occurring in the Elwha basin is included table H-1 of the Elwha Report, Appendix H.

Appendix 4

Flooding Impacts Associated With Removal of the Elwha and Glines Canyon Dams

James L. Lencioni, P.E.[1]

1. General. This report documents the technical analyses completed to estimate the potential flooding impacts on the Elwha River should the Elwha and Glines Canyon dams be removed. The results of this study will be used in the Elwha River Restoration Project Environmental Impact Statement. The design condition used in this evaluation of the impacts due to dam removal is the 100-year frequency flood. However, a federal flood control levee project provides 200-year flood protection to the east side of the floodplain through its furthermost downstream 1.5-mile reach. Removal of storage from a river system may impact the historic flooding regime of the river by altering either the hydrologic or sediment conditions downstream from the dams. Typically, the loss of storage increases peak discharge and sediment aggradation downstream from the storage site thereby increasing water surface elevations downstream. For the Elwha River, specifically, the evaluation of the flood impacts from removal of the two dams is based upon results of hydrology and sediment studies by the Bureau of Reclamation for the environmental impact statement. In summary, these studies have shown that (1) removal of the dams would not alter the existing hydrology downstream because of the dams' "run-of-the-river" mode of operation and small storage availability, and (2) removal of the dams would result in riverbed aggradation that would cause an increase in the water levels downstream from the dams.

2. Evaluation Methodology.

a. General. For this impact evaluation, the flooding regime (water surface elevation and flooded area) was developed using the HEC-2 numerical computer model. HEC-2 is a one-dimensional, standard-step method model that computes a steady-state water surface profile. The model requires channel and floodplain geometry (cross sections), water discharge rates, and energy loss coefficients (boundary roughness, channel planform and expansion/ contraction) as input parameters.

The channel boundary roughness and planform are generally combined into a Mannings roughness coefficient while expansion/ contraction coefficients are separately identified. The accuracy of computed water surface profiles and delineation of the flooded area with this, as well as any other, model is dependent upon the accuracy of the geometric data, the distance between the computational points (cross sections), the gradient of the river (proximity to critical flow), and the knowledge of the energy loss coefficients.

Site-specific energy loss coefficients are typically determined for a river numerical model by a calibration process using observed water surface elevations and coincidental river discharge data. Model accuracy is improved if the model can be verified by acceptably simulating a separate set of observed water elevation and discharge data. Model accuracy becomes more uncertain as the data at which calibrated varies from the discharges at which predictive information is desired. Because observed data is seldom available for high discharge conditions, computation of water surface profiles at large flood discharges requires extrapolation of the calibrated model to discharges well in excess of those at which calibration and verification data may be available. Such extrapolation also produces some uncertainty in computed data.

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The distance between computational points in a model (i.e., the distance between cross sections) is important to model accuracy, especially as the stream gradient increases. Accuracy improves as the distance between cross sections decreases. An insufficient number of cross sections would most likely result in a relatively high degree of inaccuracy in computed water surface elevations. As a general rule, a goal in computing reasonably accurate water surface profiles is to space cross sections typically at approximately every 5-foot drop in elevation with at least four sections per mile unless stream gradient is very flat.

Stream gradient, in general, is not highly sensitive to computational accuracy provided that cross section spacing is adequate. An exception, however, is when the stream gradient results in energy slopes approaching critical slope. At such conditions, physical (as well as computational) stability of the water depth becomes highly unstable. Therefore, computation of water surface elevations in regions of a river where the flow regime is close to critical depth leads to potentially erroneous results.

Because of all of these considerations, computed water surface elevations for any water conveyance system are subject to some degree of error and uncertainty.

b. Elwha River Evaluation.

(1) Two separate HEC-2 models were developed to assist in the flooding impacts evaluation of the dam(s) removal. One model extended the 5-mile reach from the mouth of the river to Elwha Dam; the other model extended approximately 5 miles from the US Highway 101 bridge near the upstream end of Lake Aldwell to Glines Canyon Dam. Because of the availability of cross section and floodplain topographic data, stream gradient, and observed data in the two separate reaches, the uncertainty in the computed water surface elevations and delineation of flooded areas through the two reaches is significantly different.

(2) Water surface profiles were computed for the existing condition based on channel cross section data surveyed by the Bureau of Reclamation and Corps of Engineers in 1994. Corps of Engineers 5-foot contour interval, 1-inch to 200-ft scale topographic maps developed in 1983 were used to depict overbank geometry for the cross sections in the 3-mile reach between the river mouth and the state fish rearing facility near river mile 2.8 (approximately one section per every 4-foot drop in elevation and five sections per mile). City of Port Angeles 5-foot contour interval, 1-inch to 200-ft scale topographic maps developed in 1985 were used to depict overbank geometry for the cross sections in the 2-mile reach between the state fish rearing facility and Elwha Dam (approximately one section every 4-foot drop in elevation and four sections per mile). Overbank geometry for the 12 cross sections in the 5-mile reach from US Highway 101 to Glines Canyon (one section every 18-foot drop in elevation and two sections per mile) were developed from 50-foot contour interval, 1-inch to 2000-foot US Geological Survey quadrangle maps. Flooded areas were delineated on the topographic maps and visually transferred to aerial photographs taken in May 1994.

The HEC-2 model for the reach of the river from its mouth to river mile 2.5 was adjusted to approximately match water surface elevation data predicted by earlier Corps of Engineers studies for design of the Lower Elwha River flood control project. This study for the lower 1.5 mile reach of the floodplain is documented in "Final Section 205 Definite Project Report, Elwha River, WA, Flood Damage Reduction Study" dated April 1987. The model for the reach from river mile 2.5 to Elwha Dam (river mile 4.8) was adjusted to approximately match water surface elevation data published in the 1989 Federal Emergency Management Agency flood insurance study.

The HEC-2 model for the river reach between the two dams was adjusted to reasonably (within 1.5 feet) reproduce six high water observation elevations made during the January 31, 1995, flood event which had a maximum discharge of approximately 13,000 cubic feet per second at the US Geological Survey's McDonald bridge stream gage station. However, due to the limited number of river cross sections, unavailability of adequate topographic mapping, numerous locations where the flow regime is near critical in the reach between the two dams, and extrapolation of the model well beyond the conditions at which it was adjusted, the absolute value of the computed design discharge water surface elevations developed for this reach is significantly less accurate than that for the reach downstream from Elwha Dam to the river mouth. Nonetheless, the relative difference in computed existing and with-dams-removed water elevations at a given cross section (i.e., the increase in water surface elevation resulting from removal of the dams) should be reasonably accurate assuming that the estimated or predicted aggradation in the river channel downstream from the dams after removal of the dams is reasonably accurate. Spot elevations along the Olympic Hot Springs Road and in various developed areas that appeared susceptible to flooding were obtained to assist in estimating flooded areas through the river reach between the dams.

(3) HEC-6 sediment transport modeling data developed by the Bureau of Reclamation as described in their report "Elwha River Restoration Project, Washington, Sediment Analysis and Modeling Report" dated December 1995 (Sediment Report) and independent HEC-6 modeling accomplished by the Corps of Engineers were used to estimate the dam(s) removed impact on channel geometry and, subsequently, water surface elevations through the most downstream 2 mile reach of the river where a federal flood control levee exists. In the river reach between Elwha Dam (RM 5) and RM 2, HEC-6 numerical modeling accomplished by the Bureau of Reclamation was used to estimate the increase in 100-year flood water surface elevation in both the short and long term following removal of the dams. For the reach between the two dams, sediment transport modeling was not accomplished to estimate section-by-section channel geometry changes resulting from sediment processes due to the lack of sufficient cross section data. Therefore, in this reach, the elevation of the wetted perimeter of the channel portion of the cross sections in the HEC-2 model was raised by 5 and 3 ft at sections where average computed bankfull discharge velocity is less than, and greater than 10 fps, respectively to estimate the impact of aggradation (i.e., dam removal) on water surface elevation and flooding. The 3 to 5-ft estimate of aggradation was based on apparent historical evidence of the pre-dam channel configuration in some portions of the valley downstream from Elwha Dam. Water surface increases based on an assumed aggradation of 3–5 ft in the river reach between the dams are thought to represent a conservative assumption due to the large sediment transport capacity of this portion of the river (see Sediment Report).

(4) The impacts in water surface elevation and, subsequently, flooding due to removal of the dams would be classified as short-term (up to 3–5 years following dam removal) or long-term (50 years and beyond after dam removal). The short-term impact would be directly related to the release of sediments stored behind the dams. Long-term impacts would result from the removal of the sediment

retention capability now provided by the dams which would subsequently allow the naturally occurring sediments upstream of Glines Canyon Dam to be transported to and/or deposited along the stream bed the entire distance to the mouth of the river. The short-term release of sediments from the delta deposits and, subsequently, the short-term sediment aggradation and flooding impacts downstream from the dams could be somewhat regulated by the rate at which the concrete structure of Glines Canyon dam was lowered. However, natural sediment transport processes that govern long-term flooding impacts cannot be controlled.

3. Existing Elwha River Floodplain Description. Aerial photographs of the existing 100-year floodplain for the approximately 13-mile reach of the river downstream from Glines Canyon Dam are available. The approximately 5-mile reach between Glines Canyon Dam and the US Highway 101 bridge at the head of Lake Aldwell and the initial 1-mile reach downstream from Elwha Dam to river mile 4 can generally be characterized as a largely undeveloped, relatively narrow floodplain confined by steep, forested valley side slopes. The river gradient is quite steep, averaging 40 feet per mile, resulting in relatively fast-moving water. There is no development within the 100-year floodplain on the west side of the river in this reach. However, four residential properties (three near river mile 8.4 and one near 9.7) are located within the floodplain on the east side of the river; these properties are vulnerable to floods of 5- to 25-year frequencies. Portions of the Olympic Hot Springs Road paralleling the east side of the river channel and the Elwha and Altaire campgrounds in Olympic National Park also lie within the 100-year floodplain; most of the Elwha Ranger Station facilities located near river mile 12.1 appear to be above it.

The reach between the Highway 112 bridge (river mile 3.2) and river mile 4 has a relatively broad floodplain. Three residential properties on the west side of the river and one on the east side near river mile 3.5, approximately 2–3 feet below the 100-year frequency flood elevation, are flooded at frequencies ranging from 10 to 30 years. The Dry Creek Water Association water well facilities and the well access road on the east side of the river near river mile 3.6 are also within the 100-year floodplain.

The floodplain along the river reach through the downstream three miles to its mouth broadens significantly and has a much lower gradient (approximately 15 feet per mile) compared with the upper reach. Flooding at the mouth of the river is somewhat influenced also by tidal conditions on the Strait of Juan de Fuca. Development in this portion of the 100-year floodplain includes a state fish rearing facility, the city of Port Angeles domestic water supply system and industrial water supply channel, the water well facilities for the Elwha Place Homeowners' Association and a nearby private residence, a federally constructed flood control levee on the east side floodplain through the Lower Elwha Reservation, seven residential properties in the reservation on the east side floodplain landward of the federal levee, and a residential development on the west side floodplain at the river mouth. These residences on the west side of the river mouth are protected against lower frequency (probably in the range of 10- to 50-year) floods by a locally constructed (i.e., nonfederal) levee.

The federal flood control levee project, designed and constructed by the Corps of Engineers in 1988, provides 200-year flood protection for approximately 700 acres of developed area in the lower Elwha historic floodplain from the mouth of the river upstream approximately 1.5 miles on the east bank. This 8000-foot-long levee, set back from the existing river channel at distances varying from 600 to 2400 feet, protects approximately 50 residential and public structures, the Lower Elwha Fish Hatchery, and agricultural lands. The design of this levee is documented in the Corps of Engineers report "Final Section 205 Definite Project Report, Elwha River, WA, Flood Damage Reduction Study" dated

April 1987. Approximately 100 acres (50 acres in the Lower Elwha Reservation) at the far north end of the protected area containing approximately 10 residences are still subject to flooding from a 200-year frequency flood.

4. Dam Removal Impact on Floodplain.

a. General. Flooding impacts from removal of the dams would be solely the result of sediment aggradation in the river channel downstream from the dams; dam removal would have no effect on the hydrologic regime downstream from the dams (BOR report "Elwha River Restoration Project, Development of Flood Hydrographs" dated January 1995). Sediment transport technology is subject to considerable judgement and uncertainty, and typically introduces significantly more uncertainty in computed results than uncertainties associated with computation of water surface elevations.

As general indicator of the magnitude of these uncertainties, the following results of the Bureau of Reclamation and Corps of Engineers independent HEC-6 modeling efforts through the downstream 1.5 mile reach of the floodplain are compared: The absolute difference in computed water surface elevation increases resulting from sediment aggradation between the two models varies from 0.2 to 3.4 feet at identical cross sections. The average water surface increase at identical cross sections through this reach from these two independent analyses varies by a maximum of ±1.7 ft, and is generally within ±1 ft, of the actual computed data. Variations of this magnitude in computed data are considered quite reasonable in sediment transport numerical modeling. The Bureau of Reclamation also made a number of model simulations using various assumptions to test the sensitivity of sediment gradations on computed water surface elevation. These sensitivity computations reflected water surface elevation increase differences varying from 0.2 to 2.4 feet at identical cross sections in the reach depending upon the input assumptions. This magnitude of variation is also considered quite reasonable in sediment transport analyses.

The impacts on water surface elevations presented in this study are directly dependent upon the estimated or predicted sediment aggradation values that were developed through the sediment analyses. Any errors in the predicted sediment aggradation will be directly introduced into the water surface elevation computations. In other words, if the predicted aggradation is underestimated, the water surface elevation and flood impacts resulting from dam removal will also be underestimated. Conversely, if aggradation is overestimated, the computed water elevation and flood impacts from dam removal will be overestimated.

b. Effect of Sediment Management Methods. Alternative methods of management (i.e., removal) of the sediments deposited behind the dams are evaluated in the environmental impact statement. These alternatives are (1) removal of all size deposits by natural river erosion processes, and (2) removal of silts and smaller sized deposits by dredge/slurry pipeline and removal of remaining sizes by river erosion. The sediment transport analyses for the environmental impact statement revealed that (1) materials in the silts and smaller size range would pass through the downstream river system without depositing in the channel, and (2) the long-term downstream channel aggradation resulting from elimination of the reservoirs' sediment retention capability would be greater than the short-term aggradation from release of the deposits in the reservoirs.

Therefore, the impact on flooding downstream of the dams would not be significantly different regardless of either sediment management alternative.

c. Computed Water Surface Elevations. The HEC-2 model's computed existing and with-dam(s)-removed 100-year flood condition water surface elevations at the cross sections (computation points) are listed in table 1. For the downstream 2-mile reach of the floodplain, water surface increases shown in the table are based on an average of the results from the Bureau of Reclamation and Corps of Engineers modeling analyses. Both these HEC-6 modeling analyses indicated that, in the reach between Elwha Dam and the mouth of the river, the long-term aggradation from natural sediment inflow and, subsequently, increases in water elevation would be greater than the short-term aggradation and impact on water elevation resulting from release of the sediments deposited in the reservoirs. Increased water elevations resulting from dam(s) removal shown in the table would be the greater of either the short- or long-term aggradation condition. Critical depth was encountered at some cross sections of the reach modelled between the dams. At these locations, shown by asterisks in the table, critical energy elevation is used in the flooding evaluation instead of water surface elevation.

d. Specific areas of development that would be impacted by increased flooding if the dams were removed are described below.

(1) Lower Elwha Flood Control Levee. The federally constructed levee would require an average raise of 2.5 feet its entire length to retain its present level of protection. The levee alignment is set back well away from the main thread of the present channel, located beyond the limits of the post-Elwha and Glines Canyon dams historic meander belt. Since the designers expected the dams to remain in place throughout the life of the levee project, it was not necessary to design or construct the levee structurally adequate to withstand other than low overbank velocities. If the dams were removed, sediment deposition processes might induce lateral channel instabilities sufficient to cause meandering beyond the historic meander belt and, subsequently, result in high velocity flow along the levee embankment. Such conditions would threaten the structural integrity of the levee. Approximately 1000 feet of the levee close to the historic meander belt near its upstream end potentially would be subjected to river attack as a result of aggradation-induced lateral channel migration. This portion of the levee would require a 2-foot thickness of graded riprap extending from the top of levee to the present channel thalweg elevation (approximately 18 vertical feet) to ensure structural stability under dam removal. In addition, channel lateral migration should be monitored over the life of the levee project. If the channel should migrate to within 100 feet of the levee at any location, armoring of the embankment through the threatened area would be needed. Authorization would be needed to ensure funding for such contingencies throughout the life of the levee project.

(2) Residences Near Downstream End of Levee. The federally constructed levee terminates at its downstream end approximately 500 feet upstream from the Strait of Juan de Fuca. This feature of the levee design provides a means to naturally drain the interior waters from the area landward of the levee. However, high water at the end of the levee, originating either from the river or from the tide, can flow into the most downstream portion of the protected area. At the time the levee was constructed, this type of flooding did not significantly impact the small amount of development in this area. With the present level of development, ten structures in the protected area appear to be subject to 200-year frequency floods. Approximately five additional structures located landward of the downstream end of the levee and presently protected by the levee might be subjected to backwater flooding by increased water elevation if the dams were removed. All of these structures would need to be raised approximately 1 foot or otherwise mitigated for flood impacts resulting from removal of the dams. One means of mitigation to retain the present level of protection would be to extend

Table 1. Current and Predicted Increases in Water Surface Elevations Following Dam Removal

		WATER SURFACE ELEVATION (feet)		INCREASE (feet)
CROSS SECTION NUMBER	RM	EXISTING	DAMS REMOVED	
1+00 (Levee)	0.2	7.4	8.4	1.0
2+00 "	0.5	13.6	16.4	2.8
4+00 "	0.8	20.4	24.1	3.7
5+00 "	1.1	28.4	32.4	4.0
6+00 "	1.2	32.1	35.4	3.3
7+00 "	1.4	34.9	38.1	3.2
7+50	1.6	40.4	43.7	2.3
8+00	1.9	44.7	47.7	3.0
9+00	2.2	49.6	52.1	2.5
10+00	2.5	54.6	56.6	2.0
11+00	2.6	60.4	62.1	1.7
12+00 (Fish Facility)	2.8	64.2	66.7	2.5
13+00	3.0	69.9	72.3	2.4
16+00 (Bridge)	3.3	76.0	77.9	1.9
17+00 (Intake)	3.35	77.6	79.5	1.9
19+00	3.5	78.4	80.2	1.8
20+00 (DC Wells)	3.7	83.3	84.6	1.3
21+00	4.8	104.9	106.	1.6
22+00 (Elwha Dam)	4.9	109.7	111.5	1.8
23+00 (101 Bridge)	7.7	207.8	210.3	2.5
24+00	7.9	210.4	212.8	2.4
25+00 (USGS Gauge)	8.5	232.1	234.5	2.4
26+00	9.0	239.8	241.6	1.8
27+00 (Park Bdry)	9.6	258.9	260.3	1.4
28+00	9.8	262.2	264.1	1.9
29+00	10.8	307.7	308.5	0.8
30+00	11.5	337.9	339.4	1.5
31+00 (Rangr Station)	12.0	351.3	352.1	0.8
32+00 (Bridge)	12.5	368.5	371.0	2.5
33+00	13.0	397.4	400.6	3.2
34+00	13.2	407.1	409.3	2.2

the federal levee approximately 400 feet downstream where it would tie into high ground at the dunes near the Strait of Juan de Fuca to prevent riverain and tidal backflooding around the end of the levee. This type of modification would also require construction and operation of a facility to pump interior drainage water from the protected area in order to prevent flooding from water originating landward of the levee.

(3) Locally Constructed Levee. The locally constructed levee extends from the river mouth approximately 900 feet upstream to high ground on the west bank of the river. The top of levee is at an elevation that provides a low level (estimated 25- to 50-year frequency considering the uncertainty in computed water surface elevations and structural integrity of the levee) of flood protection to portions of an approximately 30-acre area of residential properties in a generally east-west, narrow strip of land perpendicular to the river flow between the Strait and a high bluff line to the south. Because of this geographic orientation and the topography of the area, flooding is influenced by a complex combination of tidal and riverain conditions. Since specific topographic information is not available for this area, the flooding regime has not been evaluated nor the number of residences influenced by riverain flooding determined. Nevertheless, the levee would require raising approximately 1 foot to retain its present level of protection and the raised portion would need to be protected with a 2-foot thickness of graded riprap. For enhancement purposes, this levee could be realigned in a northwesterly direction to provide more lateral space for channel migration within the confines of the floodplain without compromising present flood control protection.

(4) Elwha Place Homeowners' Wells. Two domestic water supply wells for this residential association are located on the west overbank of the river near river mile 1.4. The southernmost well is in a well house with a floor elevation approximately 1 foot above the 100-year flood elevation. The top elevations of the well casings are approximately 1.5 and 2.4 feet above the 100-year frequency flood elevation. However, topographic mapping indicates that the general ground elevations surrounding the wells and well access road are at least 1 foot below the 100-year frequency elevation. Aggradation is estimated to raise the 100-year flood elevation by 3 ft. Therefore, the low well head would need to be raised by at least 3 feet and the high well head and well house by at least 2 foot (to allow for some uncertainty in the computed water elevation) to mitigate flooding impacts if the dams were removed. A private residence, located approximately 400 feet south of the wells and approximately 2 feet below the 100-year flood level, also would require raising or floodproofing as mitigation for flood impacts from dam removal.

(5) City of Port Angeles Ranney Well Collector. The city of Port Angeles receives its domestic water supply from a Ranney well collector system located on the east bank of the river near river mile 2.8. The ground elevation at the well caisson, equipment, and chlorine storage building is 62 feet, approximately the 100-year flood elevation. Since the 100-year frequency water surface elevation is estimated to raise approximately 3 feet if the dams were removed, the well, facilities, and buildings would need to be raised at least 3 feet to remain above the 100-year flood elevation. An alternative mitigation measure would be to construct a ring dike around the entire well facility. This dike could be incorporated into a more extensive levee system designed to provide flood protection for the area encompassing the fish rearing facility (paragraph 4d(6)) and city's industrial water supply channel (paragraph 4d(7)).

(6) Washington State Fish Rearing Facility. Washington State constructed and maintains a fish rearing facility on the east bank of the river near river mile 2.8-3.0. High ground elevations between the rearing channel and the river and computed 100-year frequency water surface elevations are less

than 0.5 feet of each other. Considering the uncertainty in the computed water surface elevation, flooding of the facility's ponds by the existing 100-year frequency flood cannot be firmly predicted. If the dams are removed, this facility will be flooded with 100-year floods. This flooding could be mitigated by raising approximately 1800 feet of the Crown Zellerbach water supply road located immediately west of the ponds by approximately 5 feet. Eliminating flooding of the facility would require (1) control (i.e., flapgate) to prevent water from entering the 4.75-foot diameter culvert in an entrance channel at the upstream end of the facility and (2) bulkheading capability of the screening structure at the outlet channel near the downstream end of the facility, both of which connect directly to the river. An approximately 200-foot training dike located on the right bank of the main river channel at the upstream end of the facility would need to be raised 3 feet and protected with a 3-foot thickness of riprap to maintain its present level of protection.

(7) Port Angeles Industrial Water Supply Channel. This channel is located immediately east of the state fish rearing facility channels. An access roadway on the west side of the channel is approximately 1 foot higher than the 100-year frequency flood elevation. To mitigate for the 3-foot increase in flood elevations if the dams were removed, approximately 2500 feet of this access road would need to be raised 3 feet. The Crown Zellerbach water supply road would present an alternative method to mitigate for the flooding impact to the water supply channel.

(8) Water Wells at the Fish Rearing Facility. A well field is located west (riverward) of the Crown Zellerbach road at the upstream end of the fish rearing facility. Ground elevations in this area are approximately 1 foot below the 100-year frequency water surface. These wells would need to be raised 3-4 feet to mitigate for increased flood levels resulting from dam removal. A well field is proposed in the same area, approximately 500 feet downstream from the existing wells. These wellheads, when placed, should be set at least 1 foot above the computed dams — removed 100-year water surface elevation — 72 feet at the downstream end of the well field to 71 feet at the upstream end of the field.

(9) Port Angeles Industrial Water Intake. Sediment deposition behind the water supply diversion weir near river mile 3.3 would block the entrance to the water supply tunnel and channel if the dams were removed. Replacement of this diversion weir and water intake structure by an infiltration gallery and filtration system would mitigate for this impact. Sediment aggradation at this location as a result of dam removal would increase the 100-year frequency flood water elevation by 2 feet.

(10) Left (West) Bank Residences Near River Mile 3.5. Three residential structures located near river mile 3.5 on the west overbank of the river, 2-3.5 feet below the 100-year frequency flood elevation, are presently subjected to 10- to 30-year frequency flooding. Aggradation following removal of the dam(s) is estimated to increase the frequency at which these properties would be flooded to every 5 to 15 years, and result in an increase of 2-3 feet in the 100-year water elevations in this vicinity. Mitigation by raising or otherwise floodproofing the properties to accommodate this increase would be required if present day conditions were to be retained.

(11) Right (East) Bank Residence Near River Mile 3.5 A residential property located near river mile 3.5 on the east overbank of the river, just north of the Dry Creek Water Association wells, is approximately 2 feet below the 100-year flood level and presently floods at a 10-20-year frequency. Aggradation following removal of the dam(s) is estimated to increase the frequency at which this property would be flooded to every 5 to 8 years and result in an increase of approximately 1.5 feet

in the 100-year water elevations in this vicinity. Mitigation by raising or otherwise floodproofing this property to accommodate this increase would be required if present conditions were to be retained.

(12) Dry Creek Water Association Wells and Access Road. The Dry Creek Water Association maintains four well heads on the east bank of the river near river mile 3.6, three of which are enclosed in well houses. The floor elevations of the well houses are at the 20- to 50-year frequency flood (1/2 to 2 feet below the 100-year frequency flood elevation). The ground elevation at well number 4 is approximately 4 feet below the 100-year flood elevation. If the dams were removed, the 100-year frequency flood elevation is estimated to increase approximately 1.5 ft as a result of channel aggradation. The 750-foot access road to the well heads is flooded by the 10-year frequency flood and will be overtopped up to 4 feet by the existing 100-year flood. Raising the road grade 1.5 feet would be required to mitigate for the impact of dam(s) removal. The road grade in the floodplain would need to be raised by at least 6 feet to ensure well head accessibility during the 100-year flood if the dam(s) were removed.

(13) Residences Near River Mile 8.4. Three residences are located in the 100-year floodplain on the east bank of the river near river mile 8.4. The Olympic Hot Springs Road protects two of the properties, which are 6–7 feet below the 100-year frequency flood level, from 5-10 year floods. The third residence, between the road and the river, is 3-4 feet below the 100-year frequency flood level. Estimated increases in flood elevations resulting from dam removal would be 3-3.5 feet with lower frequency floods and approximately 2.5 feet for 100-year floods. Flood impacts from dam removal could be mitigated by raising approximately 2000 feet of the Hot Springs Road by 3.5 feet to retain its present level of protection for the two properties west of the road, and raising or floodproofing all three residences to accommodate the 2.5-foot water elevation increase with the 100-year frequency flood.

(14) River Training Dike. The 300-foot training dike along the right bank of the river near river mile 8.5 upstream from the southernmost residence does not provide flood control protection but does direct high velocity river flows away from the Olympic Hot Springs Road embankment. The dike is overtopped by floods on a 25-year frequency. Flood related impacts from dam removal could be mitigated by raising the dike approximately 3 feet to retain its top elevation with respect to water overtopping elevations and armoring the raised section with a 3-foot thickness of graded riprap to withstand high velocities.

(15) Residence Near River Mile 9.7. A residential property downstream from the park boundary is immediately adjacent to the east bank of the river. The property is estimated to be at an elevation of a 25-year frequency flood and 1-1.5 feet below the 100-year flood level. Water elevations for comparable flood frequencies if the dams were removed are estimated to increase by approximately 1.5 feet. Flood impacts could be mitigated by raising or floodproofing the property to accommodate this increase in water elevation. Due to its location, the potential for bank erosion from aggradation-induced water attack on the riverbanks is increased. Erosion mitigation of riprap, 3 feet thick and 15 feet high, should be included at this location.

(16) Ranger Station Structures. The Olympic National Park Ranger Station facilities are located on the right bank of the river near river mile 12. Spot elevations taken through this area indicate that the structures are at least 2 feet above the existing 100-year flood elevation. Since aggradation from dam removal is estimated to raise the 100-year flood elevation by no more than 1 foot, mitigation for flood impacts should not be required.

(17) Altaire Campground. The Altaire Campground is located along the west bank of the river near river mile 12.5. Portions of the campground area are flooded annually, and the entire campground would be under as much as 8 feet of water during a 100-year flood. Aggradation resulting from dam removal would be estimated to increase flood levels by 2–2.5 feet.

(18) Olympic Hot Springs Road. This approximately 4-mile long road parallels the river on its east bank from US Highway 101 to Glines Canyon Dam. Two separate reaches of the road within the national park, totalling approximately 1 mile, flood at frequencies not much greater than annual to 5-year events; the remaining portion of the road is well above the 100-year flood. Road profile elevations indicate that raising the two low reaches (approximately 1 mile in length) of roadway by an average of 1.5 feet would be sufficient to mitigate for impacts resulting from dam removal. Two separate reaches of roadway downstream from the park — including that described in paragraph 4d(13) — totalling approximately 3500 feet in length, are subject to flooding at frequencies less than 100-year. Raising the road in these areas by 2–2.5 feet could mitigate for flood impacts if the dams were removed. Selected lengths of road immediately adjacent to the river channel should be riprapped with 2-3 feet of rock to mitigate for potential erosion from sedimentation activity in the river if the dams are removed.

(19) Bridges. Four bridges cross the Elwha River downstream from the dams. These are on the Elwha River Road near the state fish rearing facility, Highway 112 near river mile 4.5, US Highway 101 near river mile 7.8, and Olympic Hot Springs Road near Altaire Campground at river mile 12.6. Water elevation increases associated with sediment deposition would not be expected to affect water conveyance under the bridges. The minimum clearance to low steel on the Olympic Hot Springs Road bridge is approximately 10 feet even with the increased water elevation if aggradation occurs. The US Highway 101 bridge is a three-span arch structure; clearance under the arches with the estimated 100-year flood elevation if the dams were removed would vary from as little as 1–2 feet at the arch haunches to as much as 15–16 feet at the arch crown. Clearance under the other two bridges is very large (greater than 20 feet). Sediment transport studies indicate that bed scour would not be expected to occur as a result of dam removal; therefore, no impacts on the bridge foundations would be anticipated.

Removal of the dams would eliminate, or at least reduce, the woody debris retention presently provided by the reservoirs. The potential for increased quantities of floating, woody vegetation being transported through the downstream floodplain would be created, with, perhaps, debris impact on the in-water piers of the Highway 101 and Altaire Campground bridges. This impact could be mitigated by adding debris deflectors to the in-water piers of these bridges.

5. Flooding impacts would be directly attributable to the sediment aggradation during and following dam removal. Predicting sedimentation impacts has a relatively high level of uncertainty. Therefore, an important element of mitigation should be a formal channel sediment surveillance program to monitor aggradation and channel migration. This program should be developed and administered by a responsible government agency and should consist of:

a. Periodic channel surveys at 10–15 selected locations along the entire reach of the river downstream from Glines Canyon Dam. These locations should be coordinated with locations of the 1994 channel surveys. Cross sections should be taken every year for the initial five years following dam removal, then every five years, and after any high water event larger than a 5-year frequency for at least 25 years following dam removal.

b. An evaluation of channel surveys to compare with the base (prior to dam removal) condition. If these data indicate aggradation increases beyond those predicted by the sediment transport analysis, channel dredging or some other mitigation measure should be considered.

c. Monitoring of lateral migration of the river channel. If lateral migration begins to threaten any critical areas, banks should be armored.

In order to be effective, sufficient funding for the monitoring and evaluation program, as well as selective dredging or channel erosion protection activities, would be needed immediately and in the future.

Appendix 5

Programmatic Agreement

Following is a reproduction of the original Programmatic Agreement.

United States Department of the Interior

NATIONAL PARK SERVICE
Pacific Northwest Region
909 First Avenue
Seattle, Washington 98104-1060

IN REPLY REFER TO:

PROGRAMMATIC AGREEMENT AMONG THE NATIONAL PARK SERVICE, LOWER ELWHA S'KLALLAM TRIBE, THE WASHINGTON STATE HISTORIC PRESERVATION OFFICER, AND THE ADVISORY COUNCIL ON HISTORIC PRESERVATION REGARDING RESTORATION OF THE ELWHA RIVER ECOSYSTEM

WHEREAS, the U.S. Congress has directed (P.L. 102-495, The Elwha River Ecosystem and Fisheries Restoration Act) the Secretary of the Interior (Secretary) to study alternative strategies for the full restoration of the Elwha River ecosystem and the native anadromous fisheries in the state of Washington and removal of Elwha and Glines Canyon dams, should that be necessary; and

WHEREAS, the Secretary of the Interior has designated the National Park Service (NPS) as the lead agency for purposes of completing Sections 106 and 110 obligations for all federal agencies with responsibilities in this undertaking, and the NPS and the Lower Elwha S'Klallam (Tribe) will cooperate in carrying out the terms of this agreement; and

WHEREAS, the NPS has determined that the restoration of the Elwha River Ecosystem (Undertaking) may have an effect on properties included in or eligible for inclusion in the National Register of Historic Places and has consulted with the Tribe, the Advisory Council on Historic Places (ACHP) and the Washington State Historic Preservation Officer (SHPO) (hereinafter Parties) pursuant to Section 800.13 of the regulations (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470f; hereinafter NHPA);

WHEREAS, the Parties have considered the applicable requirements of Sections 106 and 110 of the NHPA, the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 et. seq.) (NAGPRA), and RCW (Revised Code of Washington) Chapter 27.44 (Protection of Indian Graves and Records) and RCW Chapter 27.53 (Protection of Archaeological Sites and Resources) in the course of consultation;

WHEREAS, this Programmatic Agreement addresses all phases of the Undertaking over a multi-year period, as described in the January 1994 The Elwha Report: Restoration of the Elwha River Ecosystem and Native Anadromous Fisheries; and Draft Environmental Impact Statement, Elwha River Ecosystem Restoration, October 1994; and a subsequent environmental impact statement addressing dam removal scenarios; and

WHEREAS, the Parties intend to use the provisions of this Agreement to address applicable requirements of Sections 106 and 110 of the NHPA, NAGPRA, and RCW, Chapters 27.44 and 27.53 (Protection of Indian Graves and Records and Protection of Archaeological Sites and Resources and Protection of Archaeological Sites and Resources); and

WHEREAS; the terms in 36 CFR Part 800.2, "Definitions," are applicable throughout this Programmatic Agreement, including "Historic Property" to mean any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places. Historic properties also include artifacts and remains that are related to and located within such properties; Cultural Landscapes, as defined in the National Park Service's (NPS) National Register Bulletin 30: Guidelines for Evaluating and Documenting Rural Historic Landscapes; and traditional cultural properties, as defined in the NPS' National Register Bulletin 38: Guidelines for Evaluating and Documenting Traditional Cultural Properties; and

WHEREAS; the Parties have invited the U.S. Bureau of Reclamation, U.S. Bureau of Indian Affairs, and U.S. Army Corps of Engineers to concur with this Agreement; and

WHEREAS; the Parties have provided the public with the opportunity to comment on the Undertaking;

NOW, THEREFORE, the NPS, Tribe, SHPO, and ACHP agree that the Undertaking should proceed in accordance with the following stipulations to satisfy NPS' Section 106 responsibilities for all individual aspects of the Undertaking.

STIPULATIONS

The NPS with assistance from the Tribe shall ensure that the following measures are carried out:

PROPERTIES STIPULATIONS

I. Identification, Evaluation and Effect Determination

A. Historic Properties Identification

1. The NPS with assistance from the Tribe will ensure the

completion of an historic properties inventory of the area of potential effects (APE) shown in Attachment I, prior to initiation of any construction activities or other forms of land disturbance. The studies listed in Attachment II will be undertaken to identify and evaluate resources in the APE. The inventories will be conducted in a manner consistent with the Secretary of the Interior's Standards and Guidelines for Identification of Historic Properties.

2. Consistent with any confidentiality protocols provided by the Tribe and/or described in Section 304, NHPA, all reports resulting from the historic properties surveys stipulated in I(A)(1) above will be distributed in their draft stages to all parties to this agreement for review and comment. The SHPO and other parties will have 20 days in which to comment. The NPS will address comments and submit a revised draft for a 20 day review period. Disputes arising from this review will be addressed in accordance with Stipulation IX; Dispute Resolution below.

B. National Register Evaluation

1. The NPS with assistance from the Tribe and in consultation with the SHPO will follow the procedures described in 36 CFR 800.4(c)(1 through 3) to evaluate the historical significance of all properties that may be affected by the Undertaking. If the NPS, Tribe, and the SHPO do not agree on the National Register eligibility of any property, or if the Council so requests, the NPS and the Tribe will obtain a formal determination of eligibility from the Keeper of the National Register pursuant to 36 CFR 800.4(c)(4).

2. If potential traditional cultural properties are identified, the NPS with assistance from the Tribe shall seek the participation of all appropriate Native American groups who ascribe traditional cultural value to those properties in applying the National Register criteria and evaluating the properties' historical and cultural significance.

3. The NPS with assistance from the Tribe shall ensure that full documentation of all findings of eligibility, including the SHPO's comments, are made available to all concerned parties.

C. Assessing Effects

1. The NPS with assistance from the Tribe and in consultation with the SHPO shall apply the Criteria of Effect and Adverse Effect (36 CFR 800.9) to all properties listed or determined to be eligible for inclusion in the National Register of Historic Places pursuant to Stipulation I (B) above, National Register Evaluation. The NPS and the Tribe shall provide the

SHPO with an opportunity to review and comment on their findings of effect for each phase of the undertaking before authorizing construction to proceed.

2. The SHPO will have 20 days in which to provide comments. Should the SHPO not comment within 20 days, NPS shall assume concurrence. Should NPS and the SHPO disagree, NPS shall consult according to Stipulation IX, Dispute Resolution.

3. The NPS with assistance from the Tribe shall ensure that all appropriate Native American Tribes and other interested parties are consulted in assessing effects regarding traditional cultural properties.

II. Treatment and Mitigation (non-archeological and non-traditional cultural properties)

A. NPS will make every effort to avoid impacts to historic properties identified according to Stipulation I (A) (1) above. When avoidance of a historic property that is neither an archeological nor a traditional cultural property is not feasible, prudent, or adequate, the NPS with assistance from the Tribe shall develop a mitigation plan. Mitigation will generally consist of recordation of the property in accordance with the standards of the Historic American Building Survey (HABS) or the Historic American Engineering Record (HAER) as appropriate.

B. The SHPO shall be given 15 days to review and comment on mitigation plans developed under Stipulation II (A) above. If the SHPO does not respond within 15 days, the NPS shall assume concurrence. Should the NPS and SHPO disagree, NPS shall consult according to Stipulation IX, Dispute Resolution below.

C. Prior to the initiation of any construction activities that would affect Elwha and Glines Canyon dams, properties listed in the National Register of Historic Places, the NPS shall ensure that appropriate HABS/HAER documentation, including photographs, measured or as-constructed drawings and historical narrative text, as appropriate, is completed and accepted by HABS or HAER prior to removal. NPS shall ensure that copies of this documentation will be deposited in the Library of Congress, in the Olympic National Park Archives, and with the Washington State Historical Preservation Officer.

D. NPS shall ensure that the story of Elwha and Glines Canyon dams will be interpreted to park visitors. Such interpretation will include the history and setting of the dams and reasons for removal. NPS shall ensure that an interpretive plan that includes themes and materials to be used in the interpretation be produced. NPS shall provide SHPO the opportunity to review and comment on the plan. Should the SHPO not respond within 20 days, NPS shall assume concurrence. Should the NPS and SHPO disagree, NPS will consult according to Stipulation IX, Dispute Resolution below.

III. Treatment and Mitigation -- Traditional Cultural Properties

Prior to initiating any construction activities, the NPS with the assistance of the Tribe, in consultation with other interested and appropriate parties, shall develop a plan to avoid or mitigate effects to traditional cultural properties.

IV. Treatment and Mitigation -- Archeological Properties

A. Prior to initiating any construction activities, the NPS and the Tribe, in consultation with the SHPO, will develop and attach to this agreement a Treatment Plan for the avoidance or mitigation of anticipated effects resulting from the undertaking and any related uses and activities on listed or eligible historic properties that cannot be avoided.

B. The Treatment Plan will be consistent with the Secretary of the Interior's Standards and Guidelines for Identification of Historic Properties (48 CFR 44716-44742) and Standards for Archeological Documentation (48 CFR 44734-44737), ACHP's Handbook for Treatment of Archaeological Properties (ACHP, draft 1980), and applicable state regulations.

C. If data recovery is the proposed treatment, the Treatment Plan will include, at a minimum:

1. The property, properties, or portions of properties where data recovery is to be carried out;

2. any property, properties, or portions of properties that will be affected without data recovery;

3. research questions to be addressed through the data recovery, with an explanation of their relevance and importance;

4. the methods to be used, with an explanation of their relevance to the research questions;

5. the methods to be used in analysis, data management, and dissemination of data, including a schedule;

6. the proposed disposition of recovered materials and records;

7. proposed methods for involving the interested public in the data recovery;

8. methods for securing the site against vandalism, if the site is not already protected;

9. proposed methods for disseminating the results of the work to the interested public;

10. proposed methods by which SHPO will be kept informed of the work and afforded the opportunity to participate;

11. a proposed schedule for the submission of progress reports to the SHPO.

D. The SHPO shall have 20 days to review this treatment plan. Should the SHPO not respond within 20 days, the NPS and the Tribe shall assume concurrence with the plan. Should the SHPO and NPS disagree, NPS will consult according to Stipulation IX, Dispute Resolution.

E. The NPS with assistance from the Tribe shall ensure that the Treatment Plan for the mitigation of anticipated effects on eligible properties is implemented.

V. Changes in Undertaking Area/Design

A. If, during the course of the undertaking, a change in the project area or design is determined necessary, the NPS with assistance from the Tribe shall ensure that the APE will be re-defined as necessary and inventoried, and properties evaluated in a manner consistent with Stipulation I, Identification, Evaluation and Effect Determination above. If historic properties will be affected, a Supplemental Treatment Plan shall be prepared in a manner consistent with Stipulation IV as appropriate.

B. The NPS with assistance from the Tribe will submit any supplemental treatment plans to the SHPO for review and comment. The SHPO shall have three (3) working days in which to respond. Should the SHPO not respond within the three working days, the NPS and Tribe shall assume concurrence.

GENERAL STIPULATIONS

VI. Monitoring

A. Construction

Prior to initiating any construction activities, the NPS with assistance from the Tribe and in consultation with the SHPO shall prepare and attach a Monitoring and Avoidance Plan.

1. The Monitoring and Avoidance Plan will at a minimum:

a. specify what types of discoveries will be sufficient to stop construction;

b. specify the professional qualifications of the person(s) monitoring;

c. specify the location of all listed and eligible properties to be avoided and the means by which they will be avoided;

d. specify areas and phases of the undertaking which will be monitored;

e. identify a schedule for submitting progress reports of monitoring activities to the SHPO;

f. outline methodology for recording historic properties;

g. address actions to be taken, including parties to be notified, if previously unidentified historic properties are discovered during construction;

2. The NPS with assistance from the Tribe shall develop in consultation with the SHPO and attach to this agreement, a plan for monitoring and evaluating the long-term effects, such as changes in the meandering of the river, of the undertaking on properties in the APE. SHPO shall have 20 days to comment on the plan. Should NPS and SHPO disagree, NPS shall consult according to Stipulation IX, Dispute Resolution below.

VII. Curation

A. The NPS with assistance from the Tribe shall ensure that all records and materials resulting from identification and data recovery efforts are curated in accordance with 36 CFR 79, except as provided for under NAGPRA. All material to be returned to owners or otherwise repatriated will be maintained in accordance with 36 CFR 79 and Tribal claims or conditions until their analysis is complete and they are repatriated.

B. The NPS with assistance from the Tribe will facilitate the involvement of appropriate tribes and tribal groups in the decisions related to final disposition of artifacts.

C. If a Tribe objects to any element of the disposition, it may object in accordance with NAGPRA and State law (Revised Code of Washington Protection of Indian Graves and Records). The NPS with assistance from the Tribe shall notify SHPO of any such objections.

VIII. Native American Remains

A. NPS and the Tribe shall ensure that any Native American burials or Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony inadvertently discovered during the undertaking phases, archeological fieldwork, or laboratory analysis shall be treated with appropriate respect and according to federal law, including, but not limited to, the Native American Graves Protection and Repatriation Act, Pub. L. 101- 601. As a precautionary measure, a written plan for treatment of human remains will be prepared in consultation with the appropriate tribe(s) and attached to this document before any work begins involving ground disturbance.

B. If objections are raised by the Tribe or any other Native American Tribe regarding treatment of human remains or cultural items as defined under NAGPRA, the objection will be resolved in accordance with NAGPRA and State Law. All signatories to this agreement will be notified of such disputes.

CONTRACTUAL STIPULATIONS

IX. Dispute Resolution

A. Unless otherwise specified in this agreement, should any signatory to this Agreement object in writing within 30 days to any finding(s), action(s) or plans provided for review pursuant to this Agreement, the NPS with assistance from the Tribe shall consult with the objecting party to resolve the objection. Upon receiving the written objections:

1. The NPS, as lead agency, will notify the SHPO as to the nature of the dispute.

2. The NPS with assistance from the Tribe will attempt to informally resolve said objections.

3. In the event that these attempts are unsuccessful, the NPS will invite the objecting party and the Tribe to a reconciliation meeting for the purpose of discussing the objections and resolving same. Such invitation will be issued no later than five working days after receipt of said objections and request that the meeting be held within 10 working days following receipt of the invitation.

4. If the reconciliation meeting does not successfully resolve all issues, the dispute shall be elevated to the ACHP as per Stipulation IX (B) below.

B. If the NPS determines that an objection cannot be resolved through consultation pursuant to Stipulation IX (A)(1-3) above, NPS with the assistance of the Tribe will forward all documentation relevant to the dispute to ACHP. Within 30 days of receipt of all pertinent documentation, ACHP shall either:

1. Provide the NPS with recommendations, which the NPS and the Tribe shall take into consideration in reaching a final decision regarding the dispute; or

2. Notify the NPS that it will comment within an additional 30 days in accordance with 36 CFR 800.6(b). Any ACHP comment provided in response to such a request will be taken into account by the NPS in accordance with 36 CFR 800.6(c(2) with reference only to the subject of the dispute; the NPS' responsibility to carry out all actions under this Agreement that are not the subject of the dispute will remain unchanged.

X. Reviews

The ACHP and the SHPO may monitor activities pursuant to this Programmatic Agreement, and the ACHP will review such activities if so requested. The NPS with assistance from the Tribe will cooperate with the ACHP and the SHPO in carrying out their monitoring responsibilities. The NPS shall provide a written annual report to the ACHP and SHPO of actions taken under this agreement. The first report will be due eighteen months after this agreement becomes effective, then yearly on the same date thereafter.

XI. Amendment

Any party to this Agreement may request that it be amended, whereupon the parties will consult in accordance with 36 CFR 800.13 to consider such amendment.

XII. Termination

Any party to this Agreement may terminate by providing 30 days written notice to the other parties, provided that the parties will consult during this 30-day waiting period to seek agreement on amendments or other actions that would avoid termination. In the event of termination, the NPS shall comply with 36 CFR 800.4 through 800.6 with regard to individual actions covered by this Agreement.

XIII. Failure to Carry Out the Terms of the Agreement

In the event that the terms of this Agreement are not carried out, the NPS shall comply with 36 CFR 800.4 through 800.6 with regard to individual actions covered by this Agreement.

XIV. Scope of Agreement

This Programmatic Agreement is limited in Scope to the Undertaking Phases associated with the removal of the Elwha and Glines Canyon Dams and related restoration activities, and is entered into solely for that purpose.

Execution and Implementation of this Agreement evidences that the NPS has afforded the ACHP the opportunity to comment and has, therefore, satisfied its Section 106 responsibilities for all individual actions of this undertaking.

Signatories:

William C. Walters — 4/3/95
National Park Service — Date

Frances G. Charles — 4/5/95
Lower Elwha S'Klallam Tribe — Date

4/3/95
State Historic Preservation Officer — Date

Robert D. Bush — 6/8/95
Advisory Council on Historic Preservation — Date

CONCURRING

4/12/95
U.S. Bureau of Indian Affairs — Date

Ronald R. Humphrey — 5/22/95
U.S. Forest Service — Date

William E. Haner Jr., LTC — 5/9/95
U.S. Army Corps of Engineers — Date

Dave D. Ricketts — 5/1/95
U.S. Bureau of Reclamation — Date

ATTACHMENT II

CULTURAL RESOURCES STUDIES/PLANS

ELWHA RIVER RESTORATION PROJECT

1. Cultural Landscape Inventory
2. Historic Structures/Buildings Inventory
3. HABS/HAER Studies -- Elwha and Glines Canyon dams
4. Historic Context Statements
5. Historical Archeology Research Design
6. Pre-Historical Archeology Research Design
7. Archeological Resources Inventory
8. Ethnographic Study
9. Inventory of Archival Resources
10. Historical Assessment of Elwha River Fisheries
11. Genealogical Studies of Lower Elwha S'Klallam Tribe
12. Ethno-Historic Study of Non-Native Settlements
13. Interpretive Plan -- Elwha and Glines Canyon dams

Appendix 6

Requirements for Completing the Proposed Action

Permitting

This appendix summarizes the major, on-the-ground activities required to complete the proposed action and Dredge and Slurry alternative, provides a relative (not an actual) timetable for doing so, and lists the local, state and federal permits likely to be required before each of these activities are undertaken.

Two types of actions are described in this EIS. The first are actions needed to complete the restoration of the Elwha River ecosystem and native anadromous fisheries and are called restoration activities. The others are actions which would prevent adverse impacts to natural or cultural resources or to property and are called mitigation measures. While all of the restoration activities are part of both action alternatives, only those mitigation measures required by law or agency regulations are considered an integral part of the alternatives. Others, as described in the Alternatives section of the EIS, are not required but are recommended for adoption. This appendix assumes all recommended mitigation will be adopted, lists specific actions which would take place to implement the proposed action, and links those specific actions to permits required by local, state or federal agencies.

The proposed actions associated with the restoration of the Elwha River ecosystem and native anadromous fisheries include the following:

- decommission and remove both dams
- remove trapped sediment (sediment management)
- revegetate reservoir lands
- distribute project lands
- outplant anadromous fish
- expand the Elwha Tribal Hatchery
- remove a water supply check dam

Restoration actions would be those actions required to return the ecosystem and native anadromous fisheries to natural processes. Removal of both the manmade structures and much of the accumulated material behind the dams would be required to restore the ecosystem. Fish restoration would occur naturally after dam removal, but would be accelerated by outplanting juvenile fish into the upper river. Natural Elwha stocks and physically and genetically similar stocks would be used for the restoration process. Expansion of the Lower Elwha Hatchery facility would be required for production and maintenance of juvenile fish for outplanting.

General actions required to mitigate the temporary and long term effects of restoration include the following:

- provide water use protection
- engage in off-river fish rearing
- provide flood protection
- protect tribal septic systems

- monitor resources
- provide mitigation for species of special concern
- protect cultural resources

High turbidity and suspended sediment concentration levels during dam removal would impact anadromous fish populations using the lower river. Turbidity levels would also impact paper mill production capabilities, City of Port Angeles and Dry Creek Water Association water quality, and tribal and Washington Department of Fish and Wildlife (WDFW) fish rearing capabilities. Mitigation measures would protect fish stocks and water supplies during and after dam removal. Flood protection would also be required to prevent adverse impacts caused by increased aggradation of the riverbed and water surface elevation.

A preliminary list of probable construction-related activities which generally require permits is listed below. A list of permit types required for this project is also provided following this list. Generally four types of permits would be required for this project; water quality, air quality, land use, and construction permits.

Restoration Activities

Dam Removal

Concrete Cutting
Concrete Blasting
Road Construction
Road Maintenance
Crane Pad Construction
Trucking and Hauling Material
Structure Demolition
Machinery Storage
Install Emergency Generator Equipment Housing
Install Construction Power Generating Equipment
Pumping Equipment Assembly
Separated Material Disposal

Check Dam Removal

Excavation in River
Material Removal and Hauling

Sediment Management – River Erosion Alternative

Erode Trapped Material
Construct Launching Pier
Regrade Exposed Reservoir Surfaces
Remove and Relocate Large Woody Material
Plant on Exposed Reservoir Surfaces

Sediment Management – Dredge and Slurry Alternative

Erode Trapped Material
Construct Launching Pier
Transport and Erect Dredge Plant
Dredge Lakes
Pipeline Construction
Pipe Fusing
Bury Pipe
Place Pipe and Lateral Restraints in River, Lake and Strait
Construct Staging Areas
Construct Material Separators

Fisheries Restoration

Place Structures, Offsite Rearing Facilities
Aerial Outplanting of Fry
Acclimation Pond Construction

Tribal Hatchery Expansion

Well Construction
Water Supply Pipe Construction
Upgrade Electrical Supply System
New Cistern
Building Construction
Rearing Pond Construction
New Emergency Generation Equipment Installation
New Access Road Construction
New Fencing

Major Mitigation Activities

Water Quantity and Quality Protection

Industrial Infiltration Gallery Construction

Excavation in Riverbed and Cofferdam Construction
Placing Pipe in River and Backfilling
Concrete Vault Construction
New Road Construction
Install Back flushing Pumps
Electrical Power Line Extension

Industrial Water Quality Treatment

Excavate/Widen Existing Settling Channel
Construct Concrete Mixing and Flocculation Chambers
Construct Berm and Road Along Center of Channel
Improve Existing Access Roads
Construct Sludge Removal and Disposal Equipment
Dispose of Sludge in Elwha River or at Approved Landfill

City of Port Angeles Domestic Water Supply (Ranney Well)
Drill and Install Caisson
Construct Pumphouse
Install Lateral Infiltration Piping Beneath River
New Access Road
New Electrical Hook-up

Tribal Fish Hatchery Water Supply
Excavation in Riverbed and Cofferdam Construction
Placing Pipe in River and Backfilling
Concrete Vault Construction
New Road Construction
New Well Construction and Pump Installation
Electrical Power Line Extension

Tribal Septic Systems
Construct Mound Septic Systems

Dry Creek Water Association Domestic Supply
Joint Operation of New City of Port Angeles Ranney System for
Separate Connection Supply Piping and Metering System
New Chlorination Facility
Seal Existing Wells

Elwha Place Home Owners Association
Pumphouse Construction

Private Wells
In-line Filter Systems

Flood Protection

Lower Elwha Flood Control Levee
Raise Levee
Armor Inside Face with Rip-Rap
Extend Levee to the Strait of Juan de Fuca

Private Flood Control Levee West Bank
Raise Levee
Armor Inside Face with Rip-Rap

City of Port Angeles Domestic Water Supply (Ranney Well)
Provide Flood Protection Berm

WDFW Fish Rearing Channel, Industrial Settling Channel and Local Wells
Raise Adjacent Road
Raise Well Heads

Private Residences
Raise or Flood proof Structures
Bank Erosion Protection (Rip-Rap)

Dry Creek Water Association Wells
Raise Adjacent Road

Training Dike at Park Entrance
Raise Levee
Armor inside Face with Rip-Rap

Olympic Hot Springs Road
Raise Road

Permitting

A list of likely permits is provided in the table following this discussion. Permits are grouped by related types of activity.

Permitting applications would be coordinated to ensure that effects of activities in a particular action are linked in time and impact to other actions. For instance, air quality permits would be obtained near the time of the start of construction and would depend on specific details of the construction process. Land use, construction and demolition, and water-related permits would need to be applied for in advance of construction. Several individual permit applications may be required. Permits would be submitted simultaneously so that regulators could review the entire body of actions and review the inter-relationship of the actions. Permits would be based on complete or nearly complete construction documents.

The major permitting activities required for the project are related to water issues. Most water quality and land use permits would be issued on the basis of final contract documents. The nature of this project means individual permits rather than a U.S. Army Corps of Engineers nationwide permit would be required. Construction-related permits could be applied for as individual permits or grouped together. Permit applications to Clallam County, Washington Department of Natural Resources (WDNR) and Washington Department of Ecology (WDOE) would be grouped together as much as possible. Two or three individual water-related permit applications would be required. These permits would be related and would include:

> One permit to cover the water quality modifications and activities associated with removing the dams and eroding the sediments. This permit would be applied for by the Department of the Interior (DOI) as owners of the dams. This permit might also be combined with levee upgrade construction activities since it (the upgrade) is also a federal action.
>
> One permit to cover water quality mitigation items including the Ranney well, the industrial infiltration gallery, the flocculation channel and returning flocculents to the river. The DOI could act as agent for the City of Port Angeles for this permit since DOI would design and construct the facilities. A Joint Aquatic Resources Protection Application would cover Water Quality Certification and Modification, including the state Hydraulic Project Approval and Shoreline permits.

> A final "permit," for the tribal infiltration gallery, would not necessarily be required by WDOE but would need to meet Environmental Protection Agency (EPA) and US Army Corps of Engineers (COE) requirements.

Other individual permits for construction, demolition, land use, etc. would be applied for as individual permits by DOI as part of the design and construction process.

Water Quality Permits

Permits for Section 404 of the Clean Water Act and Section 10 of the River and Harbors Act (see following table) would be applied for jointly from the COE.

Water Quality and Coastal Zone Management (CZM) Certification are the final state concurrences obtained on a project. The COE will issue the Sections 10 and 404 permits only after WDOE issues the Water Quality Certification and CZM permits. The COE initiates the permitting process by sending out public notice of the impending project including WDOE public notices. The following permits are involved in this COE-initiated process and must be completed prior to issuance of the sections 10 and 404.

- Washington Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- WDOE Costal Zone Management Certification
- WDOE Water Quality Certification
- WDOE Water Quality Temporary Modification
- Flood Control Zone Permit
- Shoreline Permit

Before these permits could be issued, WDOE and WDFW require that a Shoreline Substantial Development Permit and a Floodplain Management Plan Permit be issued by Clallam County. Shoreline permits cover activities within 200 feet of a shoreline for a body of water with a flow of more than 20 cfs. This would include all construction activities for water quality mitigation. Activities impacting only existing or new federal lands would not require shoreline permits.

National Pollutant Discharge Elimination System (NPDES) permits administered by WDOE would be required for general construction activities covering more than 5 acres. Separate permits would be issued to the contractor for each dam site and for water quality construction activities. A separate NPDES permit would also be required as part of the Dredge and Slurry alternative since the pipeline would be a point source discharge into the Strait. If the Dredge and Slurry alternative were chosen, activities would be described in the Section 404 and Section 10 permit application.

Activities for tribal infiltration gallery construction would also require an NPDES permit issued by the federal EPA.

Issuance of the Shoreline and HPA permits are prerequisite by WDOE for issuance of the Water Quality Certification and modification permits. Water quality certification permit certifies that activities meet water quality standards except as described in the water quality modification permit. The Certification would also include the state's CZM certification, showing that the project meets the requirements of the state Coastal Zone Program. HPA permits are issued by the WDFW and are intended to ensure that construction activities are conducted in a manner that protects fish habitat and migration patterns.

Other Permits

Permits for burning and dumping, motor vehicle permits, and air quality permits would be issued to the contractor at the time of construction. A surface mining permit may be required from WDNR for river diversion at Elwha Dam. If the Dredge and Slurry alternative is chosen, an easement from WDNR would be required to use state lands for placement of the pipeline in the river. A Clallam County right of way permit might also be required for pipeline placement beneath county roads.

Building, zoning, utility, and critical areas permits for construction of new water quality mitigation measures would be required from Clallam County. These would be obtained by DOI as agent for the City of Port Angeles as part of the design and construction process.

Review for impacts to species of special concern would occur under Section 10 and Section 404 processes by both USFWS and WDOE.

List of Permits

The following is a list of permits likely to be required, with reference to activities described above. This is a preliminary list based on current project understanding and may change as project details are refined. For simplicity the activities have been grouped into 13 major categories. These activity numbers are referenced in the list of permits.

List of Categories Associated with River Restoration. Permit Application by DOI would include:

1. Glines Canyon Dam Demolition
2. Elwha Dam Demolition
3. Upgrade Elwha Place Homeowners' Association Water Supply
4. Tribal Hatchery Infiltration Gallery Upgrade
5. Upgrade Corps of Engineers Flood Control Levee
6. Sediment Management and Control Activities
7. Road Reconstruction
8. Placing Slurry Pipeline (Dredge and Slurry Alternative)

Permit application by the DOI for the City of Port Angeles would include:

9. New Commercial Water Supply Infiltration Gallery
10. Flocculation Chamber Construction and Operation
11. Additional Ranney Collector for the City of Port Angeles
12. New Dry Creek Water Association Water Supply
13. New Flood Control Levee Construction

Federal/State/Local Permit and Process Requirements

Permit	Statutory Authority	Permit Required for Major Activity	State and Federal Regulatory Reference	Regulatory Agency
PERMITS RELATING TO WATER QUALITY				
Section 404 Permit -Discharge of Dredge and Fill Material	Federal Clean Water Act, Section 404 (33 USC 1344)	1,2,3,4,5,6, 8,9,10,11, 12, 13	N/A	U.S. Army Corps of Engineers Regulatory Branch
Section 10 Permit obtained jointly with a Section 404 permit	Federal Rivers and Harbors Act of 1899 (33 USC 403)	1,2,3,4,5,6, 8,9,10,11, 12, 13	N/A	U.S. Army Corps of Engineers Regulatory Branch
Coastal Zone Management Certification (CZM)	Coastal Zone Management Act (16 USC 1451 et seq.)	1,2,3,4,5,6, 7,8,9,10,11, 12,13	15 CFR 923-930	WA Department of Ecology Coastal Zone Management
Permit to Appropriate Public Waters	RCW 90.03	1,2,3,4,5,6, 8,9,10,11, 12, 13	WAC 508-12	WA Department of Ecology
Water Quality Certification	Federal Clean Water Act, Section 401 RCW 90.48.260	1,2,3,4,5,6, 8,9,10,11, 12, 13	WAC 173-225	WA Department of Ecology Environmental Review
Temporary Modification of Water Quality Criteria	Federal Clean Water Act RCW 90.48	1,2,3,4,5,6, 8,9,10,11, 12, 13	WAC 173-201; WAC 173-222	WA Department of Ecology Environmental Review
Flood Control Zone Permit	RCW 86.16	1,2,3,4,5,6, 8,9,11,12,13	WAC 173-158	Clallam County
National Pollutant Discharge Elimination System (NPDES)	Federal Clean Water Act RCW 90.48; RCW 90.50; RCW 90.52	1,2,3,4,5,6, 8,9,10,11, 12, 13	WAC 173-220; WAC 173-216	WA Department of Ecology Water Quality

Federal/State/Local Permit and Process Requirements

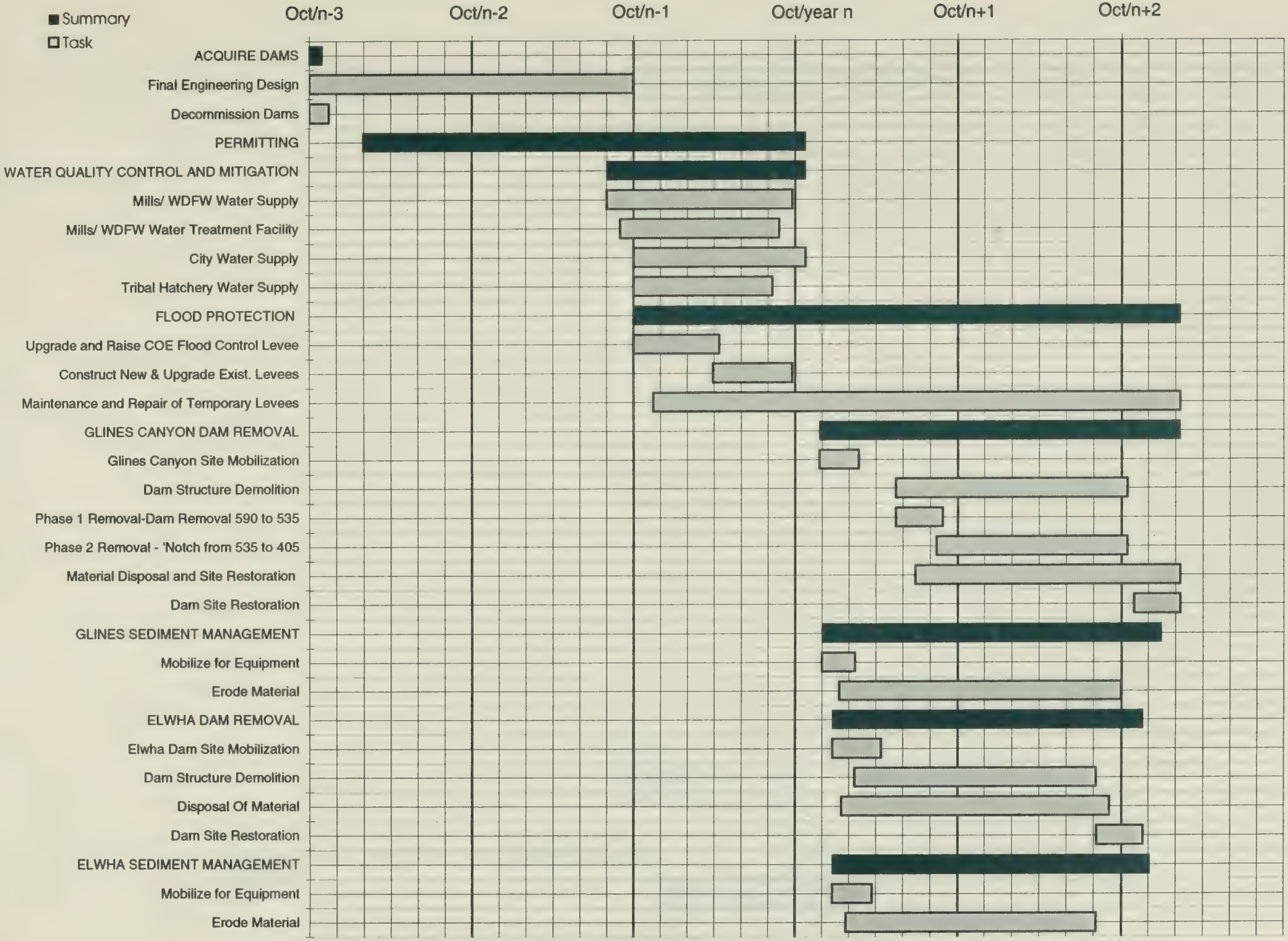
Permit	Statutory Authority	Permit Required for Major Activity	State and Federal Regulatory Reference	Regulatory Agency
Hydraulic Project Approval (HPA)	State Hydraulic Code RCW 75.20; RCW 75.08.080; RCW 75.08.112; RCW 75.20.100	1,2,3,4,5,6, 8,9,10,11,12 , 13	WAC 220-110	WA Department of Fish and Wildlife
Shoreline Substantial Development Permit	State Shoreline Management Act of 1971 RCW 90.58; RCW 36.70	1,2,3,4,5,6, 7,8,9,10,11, 12,13	WAC 173-14 to 173-28	Clallam County Department of Community Development
Floodplain Management	N/A	1,2,3,4,5,6, 7,8,9,10,11, 12,13	N/A	Clallam County Department of Community Development
PERMITS RELATING TO AIR QUALITY				
Air Quality: New Source Construction Approval	Federal Clean Air Act RCW 43.21A; RCW 70.94	All	WAC 173-400; WAC 173-405; WAC 173-410; WAC 173-415; WAC 173-490	Olympic Air Pollution Control Authority
Air Quality: Air Contaminant Source Registration	Federal Clean Air Act RCW 70.94	All	WAC 173-400	Olympic Air Pollution Control Authority
Air Quality: Prevention of Significant Deterioration (PSD)	Federal Clean Air Act RCW 43.21A	All	40 CFR 52.21; WAC 173-400	Olympic Air Pollution Control Authority
Special-Use Permit	FSM 2712	2	36 CFR 251.54	U.S. Forest Service Olympic National Forest

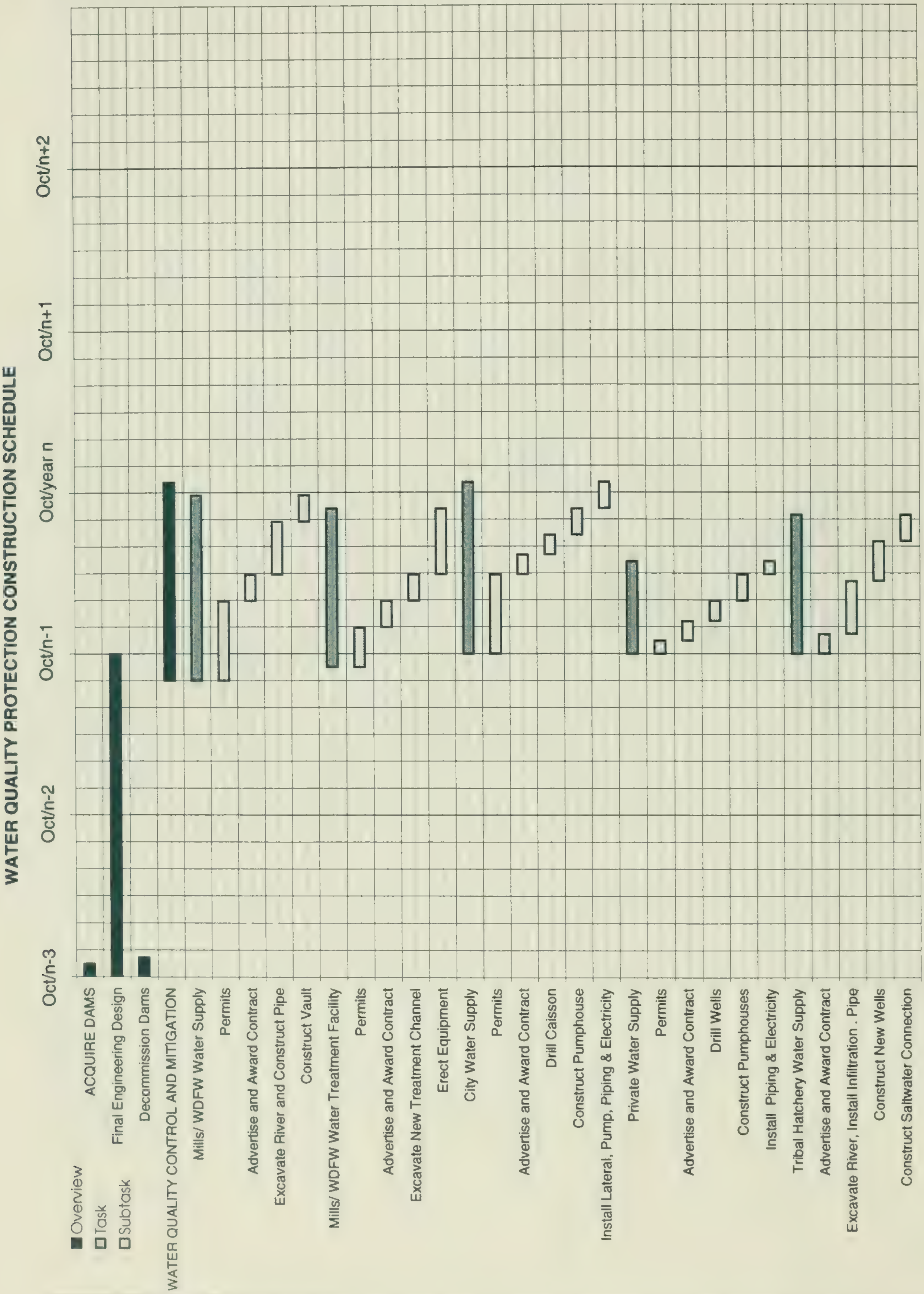
Federal/State/Local Permit and Process Requirements				
Permit	**Statutory Authority**	**Permit Required for Major Activity**	**State and Federal Regulatory Reference**	**Regulatory Agency**
ENVIRONMENTAL PROCESSES				
Cultural Resource Impact Review	National Historic Preservation Act, Sec. 106	1,2,6,7,8,9, 10,13	36 CFR Part 800	State of Washington Office of Archaeology and Historic Preservation
Washington State Environmental Policy Act (SEPA)	RCW 43.21	All	WAC 197-11	Works in conjunction with NEPA
Endangered Species Impact Review	Endangered Species Act, Sec. 7; USC 1531 et seq.	----	----	Works in conjunction with Sections 404 and 10
WASHINGTON DEPARTMENT OF NATURAL RESOURCES PERMITS				
Surface Mining Permit	RCW 78.44	2,6,7	WAC 332.18	WA Department of Natural Resources
Burning Permit	RCW 76.04	2,6,8,9,11, 13	WAC 332.24	WA Department of Natural Resources
Easement to Use State Lands	N/A	6,8	N/A	WA Department of Natural Resources
Dumping Permit	RCW 76.04	1,2,7,11,12, 13	N/A	WA Department of Natural Resources
Right-of-Way or Road Use	N/A	8	N/A	WA Department of Natural Resources
Permit to Temporarily Remove or Destroy Survey Monument	N/A	1,2,5,6,7,13	N/A	WA Department of Natural Resources
Special Motor Vehicle Permit	N/A	1,2	N/A	WA Department of Transportation Motor Carrier Services

Federal/State/Local Permit and Process Requirements

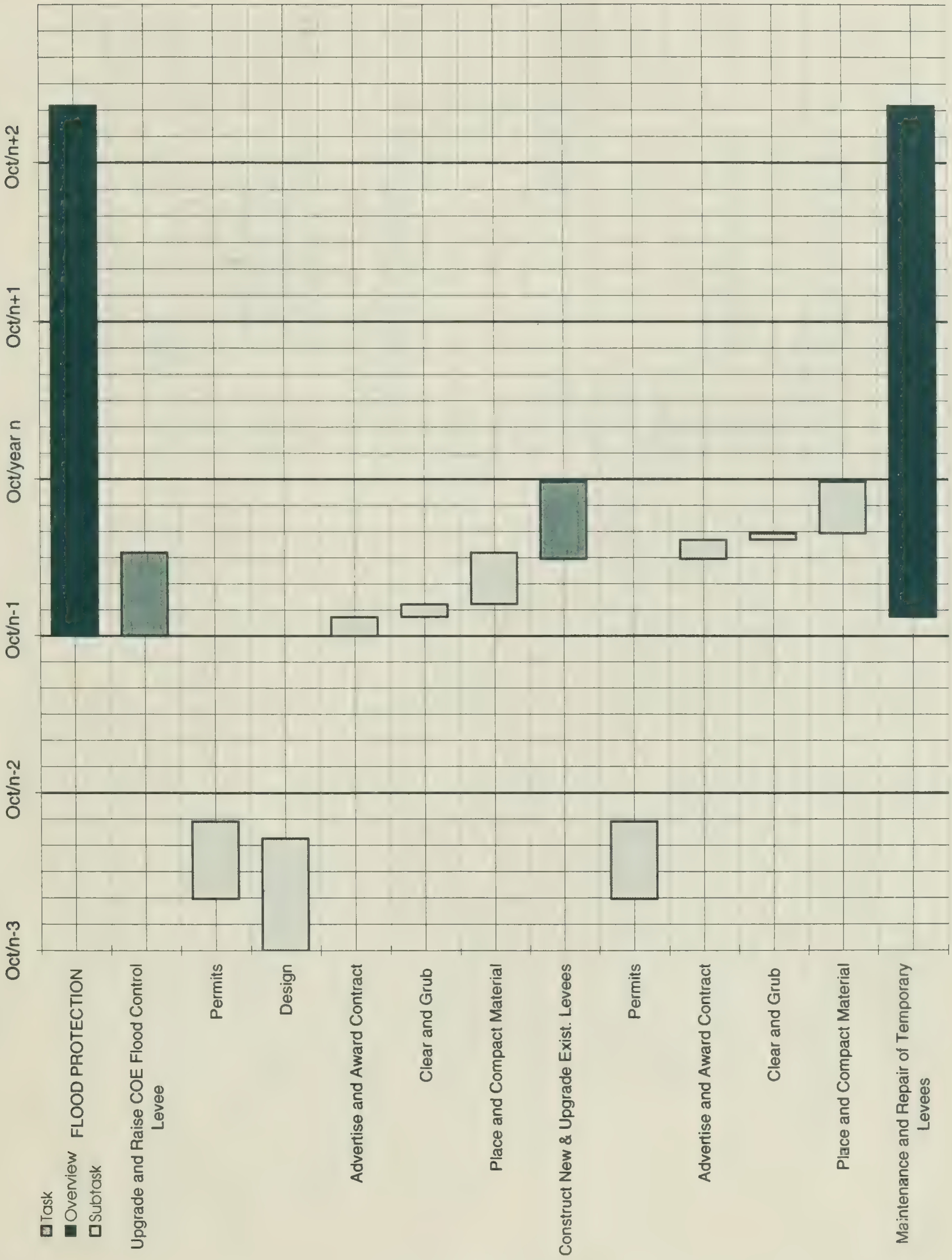
Permit	Statutory Authority	Permit Required for Major Activity	State and Federal Regulatory Reference	Regulatory Agency
CLALLAM COUNTY PERMITS				
Zoning Conditional Use Permit	N/A	2,3,5,6,7,8, 9,10,11,12, 13	N/A	Clallam County Department of Community Development
Critical Areas	N/A	2,3,5,7,8,9, 10,11,12,13	N/A	Clallam County Department of Community Development
Building Permits: Demolition Permit Drainage Permit Utility Permits Construction Permit	N/A	2,3,5,6,7,8, 9,10,11,12, 13	N/A	Clallam County Department of Community Development
Road Approach Permit	N/A	Same as above	N/A	Clallam County Road Department
Right-of-Way Permit	N/A	2,5,6,7,9,10, 12,13	N/A	Clallam County Road Department
MISCELLANEOUS PERMITS				
Archaeological Excavation Permit	Executive Order 11593 (OAHP) RCW 27.44; RCW 27.53	1,2,3,4,5,6, 8,9,10,11, 12, 13	WAC 25-48	State of Washington Office of Archaeology and Historic Preservation
Forest Practices Approval	Forest Practices Act RCW 76.09	2,9	WAC 222	WA Department of Natural Resources
RCRA Covers: Solid Waste, Hazardous Waste, and Underground Storage Tanks	Resource Conservation and Recovery Act (RCRA)	2	40 CFR, Parts 240-271	Washington State Department of Ecology
Underground Storage Tank (UST) Notification Requirement	RCW 90.76	2	40 CFR 280.22 WAC 173-360	Washington State Department of Ecology Underground Storage Tanks Division

OVERVIEW OF CONSTRUCTION SCHEDULE



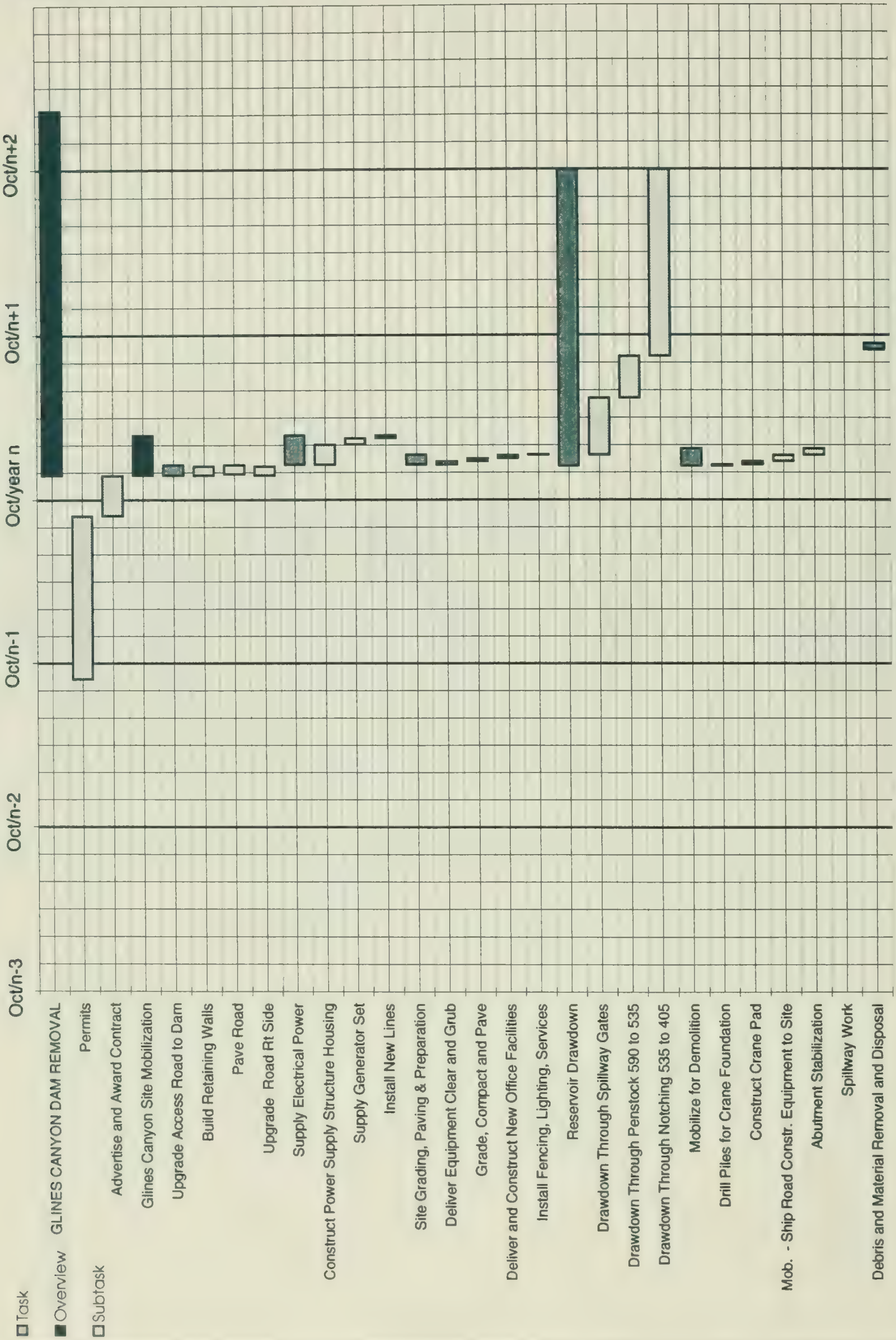

WATER QUALITY PROTECTION CONSTRUCTION SCHEDULE

FLOOD PROTECTION CONSTRUCTION SCHEDULE

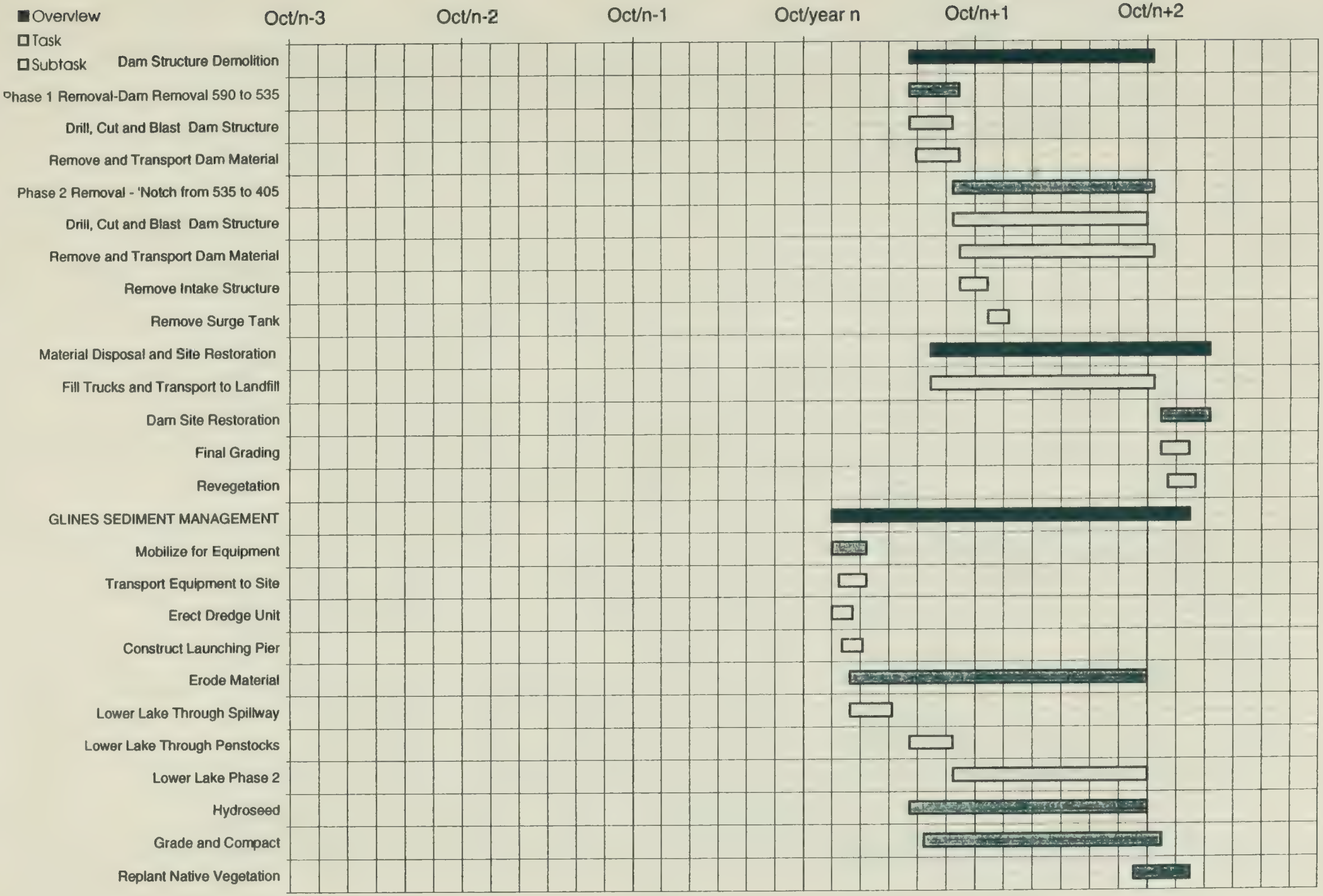


GLINES CANYON DAM DEMOLITION SCHEDULE

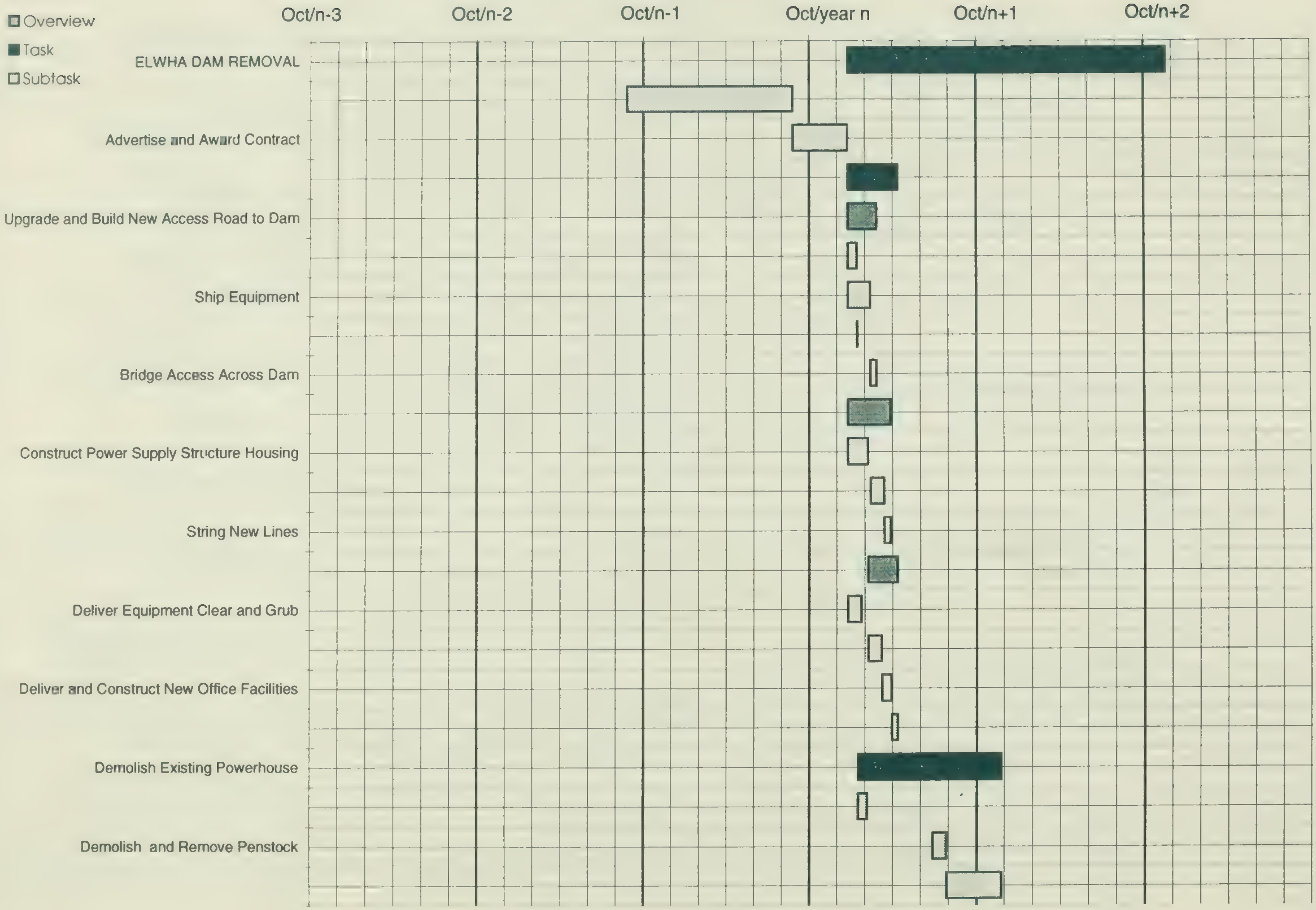
Part 1

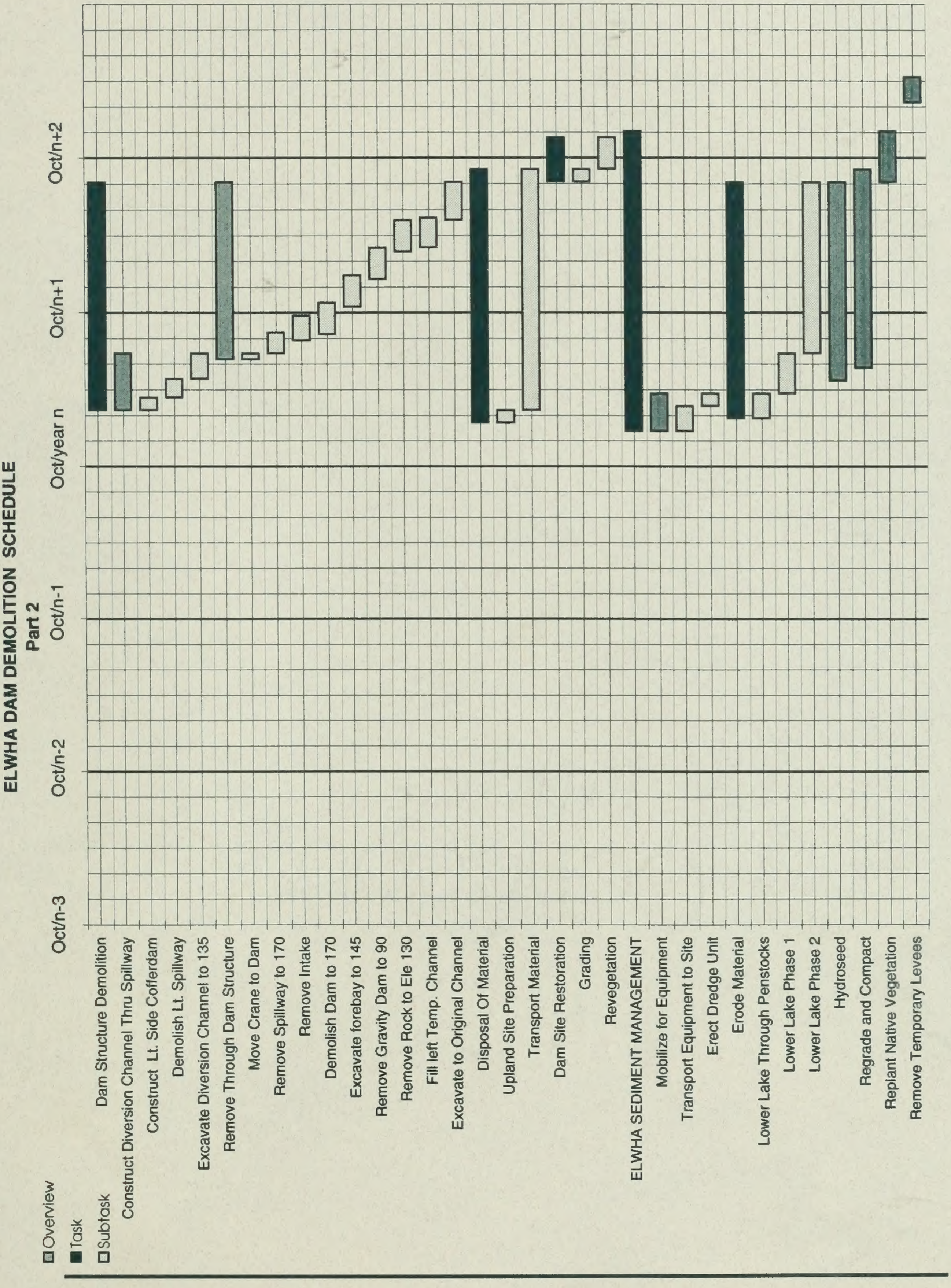


GLINES CANYON DAM DEMOLITION SCHEDULE
Part 2



ELWHA DAM DEMOLITION SCHEDULE
Part 1

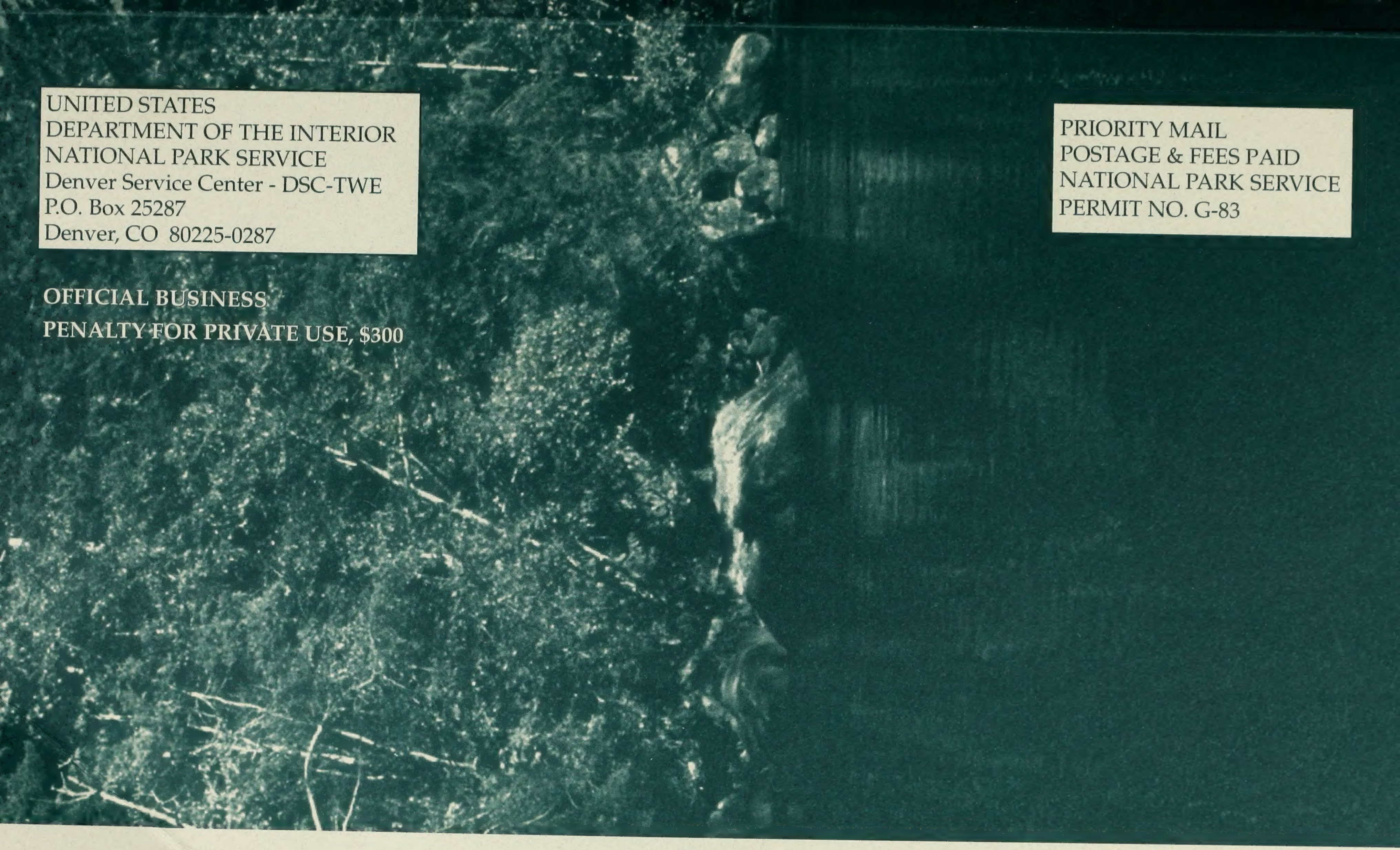




ELWHA DAM DEMOLITION SCHEDULE
Part 2

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-271, April 1996



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